March 1943

AVIATION

The Oldest American Aeronautical Magazine

McGRAW-HILL PUBLISHING COMPANY INC

IN THIS ISSUE

How North American Builds B-25's

PRICE 50 CENTS PER COPY

AVIATION

March, 1943

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CONTENTS

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Aviation is indexed in Guide to Periodical Literature, and in Industrial Arts Index.

In this Issue

Coming

Schedules for the April Issue is an article on the conversion of Consolidated B-24 *Liberator* bombers to *Liberator Express* cargo carriers. This articles describes how one plant has made its production lines so flexible that both bombers and cargo planes are turned out from the same line, and also describes the design changes made to effect this conversion. Another important story is a new approach to visualizing airflow which is of considerable value to the research function.

DIVIDE BY 6 AND ADD

35,000 Feet

TAKE the industrial generator shown here (in blue). Divide its weight—280 pounds—by six. Then give it special insulation and other features to permit its operation at 35,000 feet altitude or more. The result is the G-E aircraft generator—light, compact, high-altitude conditioned.

The two generators shown have the same capacity. The larger one is a standard type widely used in industry. The smaller is the aircraft generator used on most of our military planes today. It is built by General Electric, and by others to G-E design.

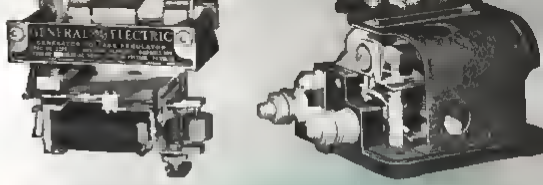
This generator is an example of how electricity, and electrical engineering skill, are helping aircraft designers to increase power and to control weight. Before Pearl Harbor, an aircraft generator then considered light weighed 30 pounds, and had a relatively small capacity. Today, with power demands for individual planes greatly increased, the capacity of the generator has risen substantially, yet weight has increased only a few pounds. This represents a considerable advantage to designers of our military planes.

As ships increase in complexity, the need for automatic operation becomes more pressing—to free air-crew members for more important duties. The resources of General Electric are devoted to the manufacture of such automatic systems. Systems that automatically position cowl flaps and intercooler shutters, synchronize the operation of two or more parts of the ship, control armament—take over flight operations formerly performed by the ship's crew. The flexibility, reliability, and light weight of electric control and operating systems are reasons why many designers have come to make it electric when they make it automatic. *General Electric, Schenectady, New York.*

Aircraft electric systems designed and manufactured by General Electric make possible the automatic control of many different flight operations. The degree of secrecy required is so great that we cannot publish information about these integrated systems now. We are glad, however, to discuss the application of automatic electric systems to aircraft with design and production engineers.

GENERAL ELECTRIC

876-5-2550



G-E voltage regulators, to maintain correct voltage, and relays to control generator current flow complete the electric generating system. Each of the three units is designed to function with the others as part of a co ordinated system.

TYPE P-1 AIRCRAFT GENERATOR

The Army-Navy "E" for Excellence in the manufacture of war equipment now flies over six G-E plants employing 200,000 men and women.

HERE'S AMERICA'S NEWEST WEAPON IN THE BATTLE OF PRODUCTION!

MODEL "47" SKILDRILL
HEAVY DUTY 1/4 IN. DRILL FOR FASTER "SKIN-DRILLING"!

...ILLS ... right ... etc. Swivels ... through 360° ... of angles in any plane. 1/4 in. cap chuck.

...for ... Drills at any ... holsters, operator handles ... feel for women workers. ... Used with or without KETT UNIVERSAL ...

MODEL 47 SKILDRILL $36

Here is just the tool you need for fastest, most accurate ¼ in. drilling in constant 3-shift production. Like the famous Model "45" SKILDRILL (thousands now in use!) it's small, compact, light for easiest handling—but it has *even greater power* for your toughest jobs . . . *greater drilling speed under load* for more output per man!

Both in construction and design New Model "47" SKILDRILL has every feature you need. Compact die-cast body, helical-cut gears and 100% anti-friction bearing construction assure smoother, easier operation. Extra-Powerful Universal Motor provides peak drilling speed up to ¼ in. in steel, ½ in. in wood. Available in 4 speeds (1800, 2500, 3500 and 5000 R.P.M.) to fit every drilling need. Weighs only 3½ lbs.; only 7¼ in. long and 2⅛ in. wide. Ask your distributor for a demonstration—once you see this tool in action you'll see why you need it now to boost production!

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Indianapolis • St Louis • Kansas City • Atlanta • New Orleans
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HERE'S THE FAMOUS MODEL "45" SKILDRILL

The *preferred* drill in every field for easy handling and fast precision production drilling. Thousands in use even by women doing day-long drilling on assembly lines. Plenty of power and speed to keep pace with today's stepped-up schedules $32.50

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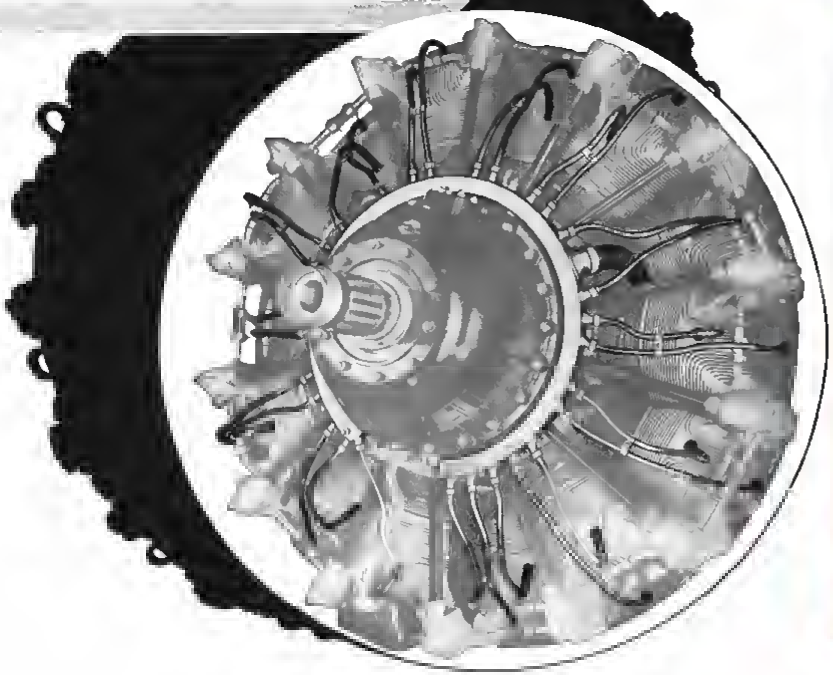
★ MAKE AMERICA'S HANDS MORE PRODUCTIVE ★

SHIELDING *for fighters...*



PRATT & WHITNEY TWIN WASP ENGINE
EQUIPPED WITH
BOLTON SHIELDED IGNITION HARNESS

The complex system of radio shielding illustrated above, designed to exclude spark interference from the ears of the operator, is but one of a number of Bolton products now being made for the U. S. Army Air Force, the U. S. Navy, and leading manufacturers.

BOLTON MANUFACTURING CORPORATION

692 CAMPBELL AVENUE · WEST HAVEN · CONNECTICUT

Portrait of the Solution to a Mathematical Problem

As colorful and beautiful as a rainbow, this could be a portion of a butterfly's wing. Actually, it is a color picture of the stress patterns of an airplane spar, taken by means of a polariscope, under laboratory conditions which simulate the air loads encountered by an airplane in actual flight.

This optical method of stress analysis known as *photo-elasticity*, supplements, and to a large degree eliminates, much of the long drawn out and laborious work necessary in the mathematical determination of stresses.

Working toward the further development of photo-elasticity, with the Department of Applied Mathematics at Washington University, McDonnell engineers believe this method of stress analysis will contribute greater speed and accuracy to the determination of structural components and materials necessary in the development of even lighter, stronger, and more efficient aircraft.

Right now, of course, all our plants are working 24 hours a day making planes, parts, and plastics for our Armed Forces. But in busy laboratories and research departments, our designers and engineers are working constantly toward the needs of the future as well as the present.

McDONNELL *Aircraft Corporation*

Manufacturers of PLANES · PARTS · PLASTICS ★ SAINT LOUIS - MEMPHIS ★

daily . . . MORE MORE MORE . . .

AEROCRAFT TOOLS

take their places on the production and service fronts

Aerocraft Tools are doing their part to win the war on every production and maintenance front—by speeding the delivery of 'planes and the servicing of them. Especially designed for their particular jobs, each tool in the extensive Aerocraft line is the result of close study of production and maintenance tool-problems. Write for the new Aerocraft Tool catalogue—many new tools are shown in it that will help your personnel in their drive for victory.

Aircraft TOOLS, INC.
LOS ANGELES, CALIFORNIA

REPRESENTATIVES: The A. R. Williams Machine Co. Ltd. Toronto, Hamilton and Vancouver, Canada ★ The Canadian Fairbanks-Morse Co., Montreal, Canada ★ Reginald M. Levy, Melbourne, Australia ★ Morris Block & Matheson, Ltd., Auckland, New Zealand ★ Emilio Staub & Cia. Ltd.—Sao Paulo and Rio de Janeiro, Brazil, S. A. ★ W. A. Ramsey Ltd., Honolulu, Hawaii

What big ears you have!

Long before the first faint hum of a plane can be heard, these giant ears have detected it and the anti-aircraft guns swing into menacing position.

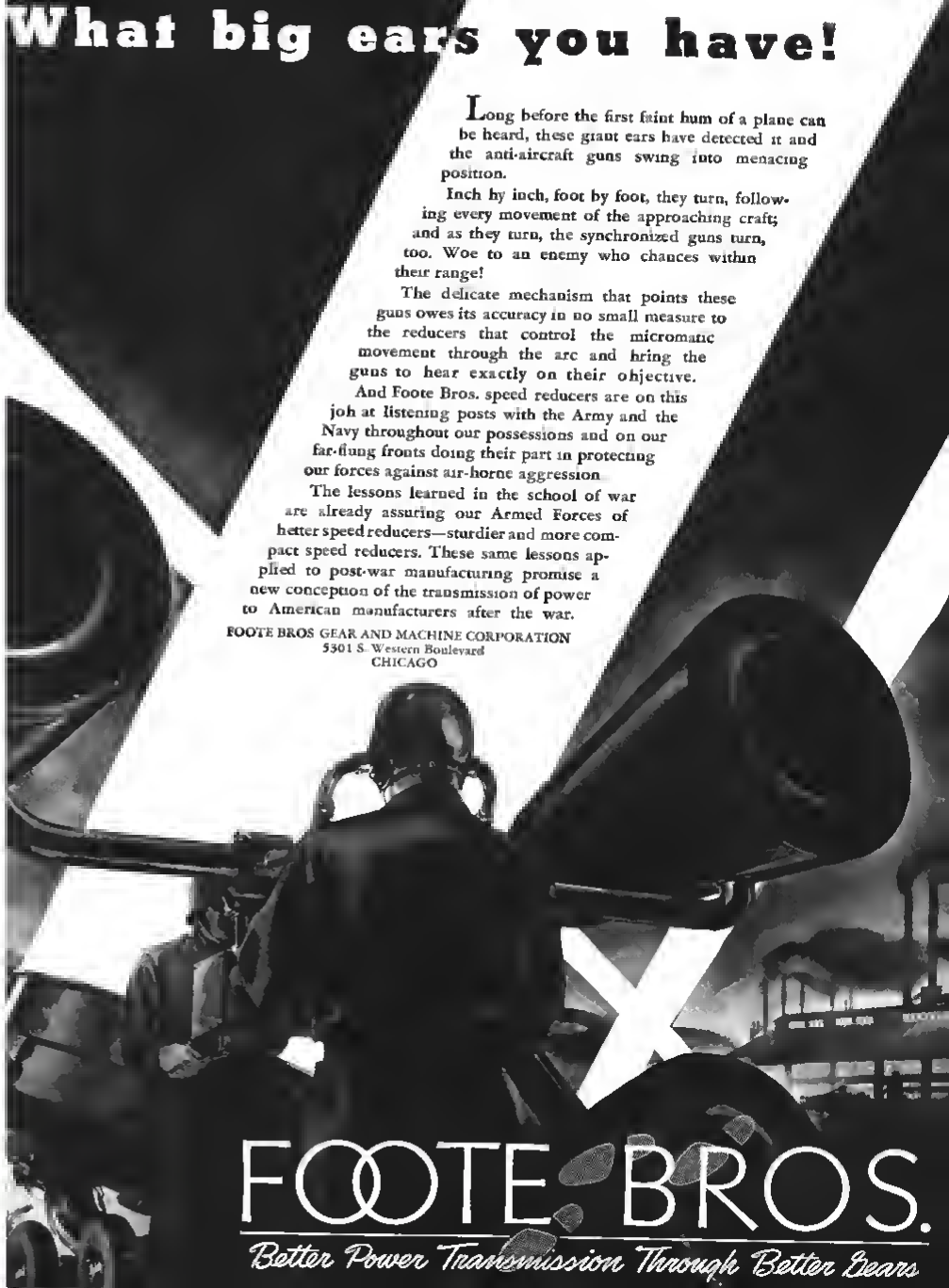
Inch by inch, foot by foot, they turn, following every movement of the approaching craft; and as they turn, the synchronized guns turn, too. Woe to an enemy who chances within their range!

The delicate mechanism that points these guns owes its accuracy in no small measure to the reducers that control the micrometric movement through the arc and bring the guns to bear exactly on their objective.

And Foote Bros. speed reducers are on this job at listening posts with the Army and the Navy throughout our possessions and on our far-flung fronts doing their part in protecting our forces against air-borne aggression.

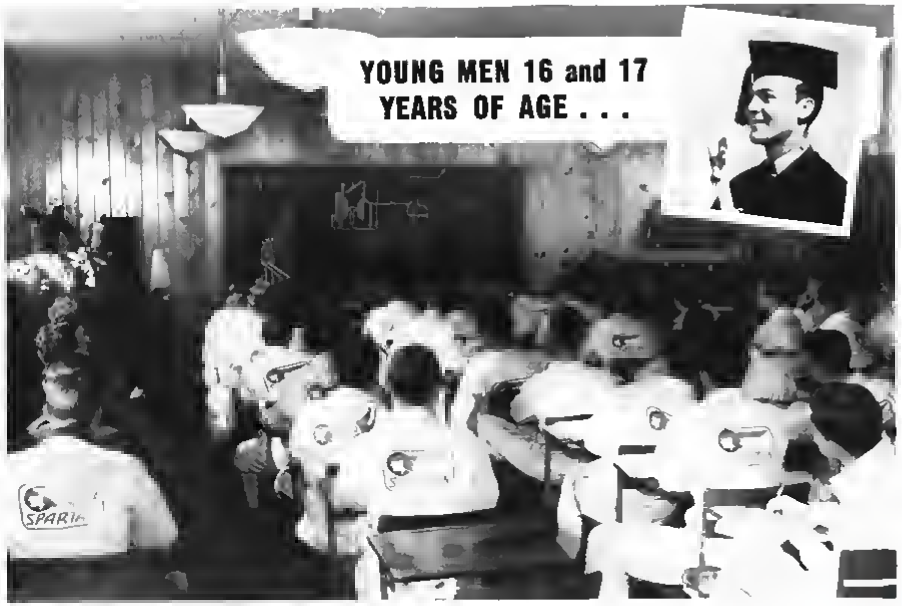
The lessons learned in the school of war are already assuring our Armed Forces of better speed reducers—sturdier and more compact speed reducers. These same lessons applied to post-war manufacturing promise a new conception of the transmission of power to American manufacturers after the war.

FOOTE BROS GEAR AND MACHINE CORPORATION
5301 S. Western Boulevard
CHICAGO



FOOTE BROS.

Better Power Transmission Through Better Gears



Finish Your Education for a Lifetime Career at the "UNIVERSITY of AVIATION"

You needn't let the war prevent you from finishing your education after high school. You can step right into the "University of Aviation" for a complete technical education that can lead you to one of the greatest lifetime careers of the future!

Here at SPARTAN School you can secure the kind of specialized training young men of America need today. You can become a skilled aviation technician and reap the advantages accorded such men when and if you are called to military service. You will be in the industry that ranks at the top in America's march to victory. You will be preparing yourself for an important place in the great post-war commercial aviation industry.

Hundreds of young men like yourself are now training at SPARTAN School to serve their country in a more valuable way . . . to be ready when peace comes for a colorful lifetime career in aviation.

SPARTAN is rated as the outstanding civil aviation training school in the U. S. Its 29 modern buildings, extensive shops and laboratories, great fleet of training planes, seven flying fields, skilled instructors and college like system of educational training offer you advantages obtainable at no other school of its kind in the country.

A New Era in Aviation Ahead—All the world will be within easy reach of the men who are a part of the great aviation industry of the post-war "Age of Flight." And the young men who prepare themselves with proper aviation training now, whether for a place in the air or on the ground, will be the ones ready to take advantage of the big opportunities for a prosperous lifetime career immediately after the war. SPARTAN offers you unequalled opportunities in all the career courses listed in the coupon below. Mail it now! NEXT SEMESTERS START MARCH 15th and MAY 24th

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Incredible Uncle Ishmael

...the one-man army!

UNCLE ISH is the derndest feller. He paid 4½ cents for that weapon, and he can shoot a clay pipe right out of your mouth at 100 yards. What's more, he's a one-man army. . . . Incredible? Well, here are the facts:

The famous Robbins & Lawrence and E. G. Lamson companies, ancestors of Jones & Lamson, had working for them in the 1800's two of the finest gunsmiths in the world. They were Albert Ball and Benjamin Tyler Henry, and the genius of these two men contributed much to the invention of a gun that was destined to make history.

That gun is known throughout the world today as the famous Winchester rifle — but in an earlier form, as the Ball lever-action repeater, it was known only as a headache to E. G. Lamson & Co. For there was a large order from the government for this revolutionary firearm, to replace the muzzle-loaders being used in the Civil War, but the war ended before delivery could be made.

The result. Hundreds of these repeating rifles were put up for sale at one-half cent a pound—and Uncle Ishmael got one. Nine pounds of the greatest gun in the world, for 4½ cents!

Later, when the patent for Ball's lever-action magazine was purchased and combined with improvements in rifle design made by Henry and another gunsmith named King, the great Winchester rifle was born. And it was an early advertisement for this rifle that told how Uncle Ishmael was a one-man army. "A man armed with one of these rifles," it read, "can load and discharge one shot every second, so that he is equal to a company every minute, a regiment every ten minutes, a brigade every half-hour, and a division every hour!"

The company in which that famous firearm had its origin is known today as Jones & Lamson, and the gun is typical of many great American products that have stemmed from the tools — and the men — developed by this company.

Jones & Lamson engineers and service men are at your call today . . . right now . . . to help you in solving the difficult problems of present and post-war readjustment.

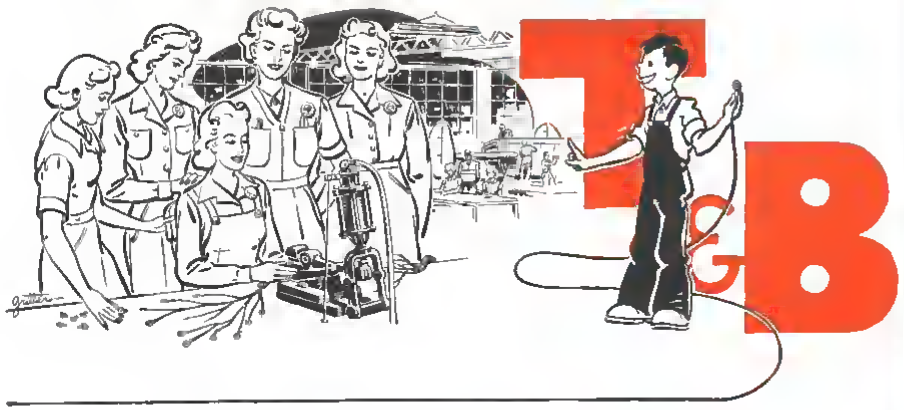
JONES & LAMSON

Machine Company

SPRINGFIELD, VERMONT, U. S. A.

Profit-producing Machine Tools

Manufacturers of Ram & Saddle Type Universal Turret Lathes . . . Fay Automatic Lathes . . . Automatic Thread Grinding Machines . . . Comparators . . . Automatic Opening Threading Dies and Chasers.



T&B

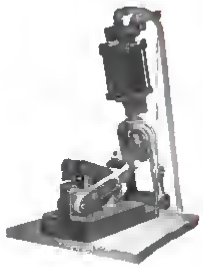
EXPERT ASSEMBLERS IN ONE EASY LESSON

WITH

STA-KON TERMINALS

AND

STA-KON TOOLS



A typical T & B Air-operated STA-KON Tool

The installation of T & B small wire terminals hangs up speed records when green help on the assembly line is equipped with Sta-Kon Power Tools.

No solder, muss or danger. Quick, permanent installations every time.

The STA-KON Tool shown here is air-powered. Other STA-KON Tools utilize other power sources —manual, air, electric or hydraulic. Various models install STA-KONS on wire sizes #22 to 4/0 Aircraft. Small hand tools are also available for wiring on the air-frame itself, in cramped quarters, etc.

Write for Bulletin 500, just off the press. Complete information, blueprints and engineering data on STA-KONS and STA-KON Tools.

Made by makers of famous Wedge-On and Tite-Bind Pressure (Sobleless) Connectors.

T&B

THE THOMAS & BETTS CO.

INCORPORATED

MANUFACTURERS OF ELECTRICAL FITTINGS SINCE 1899

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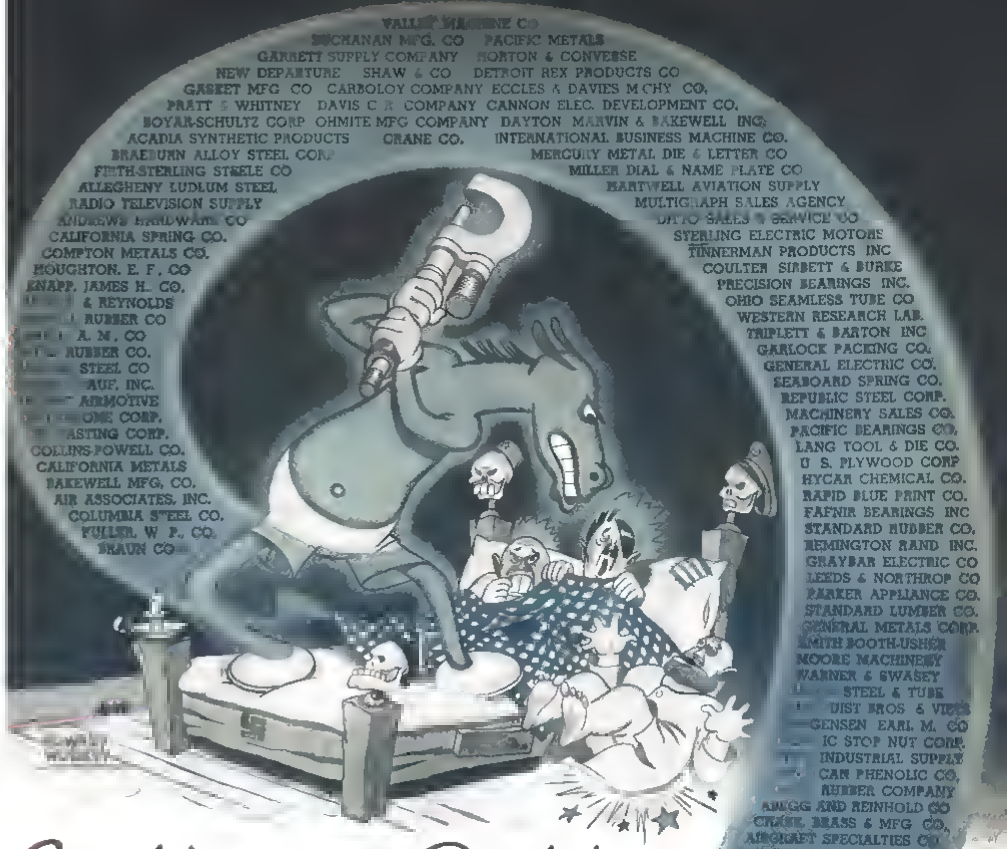

Nightmares for Dictators

MADE IN U. S. A.

ADEL salutes the hundreds of manufacturers and supply companies both large and small who are helping the aviation industry make this dream a fearful reality for the Axis partners. To you and to your workmen we say MAKE EVERY MINUTE COUNT! Though the parts and supplies you furnish may individually seem unimportant remember that Uncle Sam puts wings around them to help our fighters deliver block busters that will soon put an end to aggression. When? It's up to YOU—to your work and purchases of War Bonds and Stamps!

Manufacturers of 3,000 types and sizes of line support, hydraulic, anti-icing and allied aircraft equipment.

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363 Bay Street TORONTO, ONT., CANADA

Bruiser

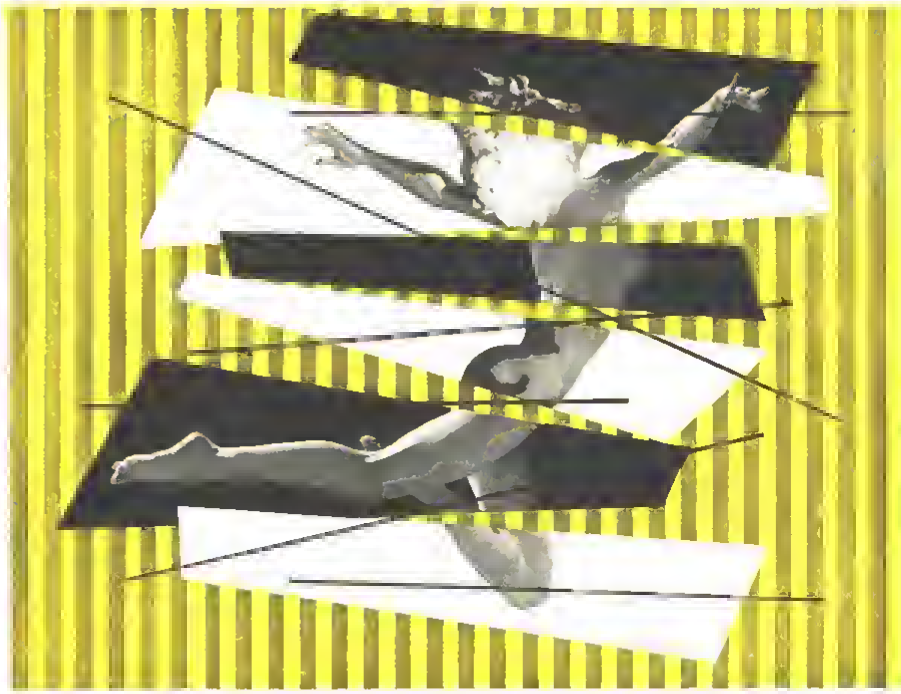
This is the Vega Ventura, a tough looking rough acting new bomber with some definite family characteristics. It *looks* like the Hudson only bigger. It's sleek and powerful with stamina in every spar. It acts like the speedy record breaking airline Lodestar only faster and more maneuverable. In action it's a *bruiser*, the biggest, hardest-hitting bomber yet designed and produced by Vega. It carries a bellyful of destruction in its whopping bomb bay and throws 50 caliber death from five gun positions.

United States and Royal Air Force pilots can tell much more about this deadly bomber in the days to come, and they *will* in stories of blasted Axis supply lines, smashed Axis tanks and silenced Axis guns.

A subsidiary of Lockheed

Vega

Aircraft Corporation



This machine can be improved!

THE HUMAN BODY, we've all been told, is the most perfect machine ever devised. Poets, doctors and engineers all agree on this point.

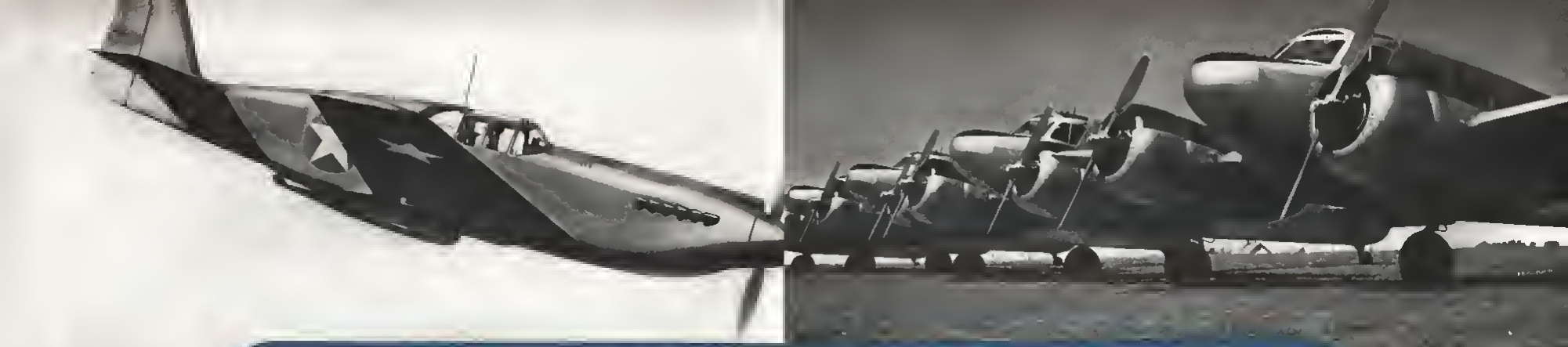
Yet even the human body is capable of change and improvement. Take life expectancy, for example. Less than 100 years ago it was 35 years... today, it is 63.3! And our soldiers today are 2 inches taller and 14 lbs. heavier than they were during the last war.

The important thing about these figures is this. No matter how highly developed a machine may be... no matter how miraculous its accomplishments may seem, never make the mistake of assuming it cannot be improved. Mistakes like this have caused the failure of more than one flourishing business!

The machine tool industry is busy today making machines to make the 45,000 parts of bombing planes, 40,000 parts for tanks and the multiple parts and instruments for ships, cannon, rifles, torpedoes and shells. And as a result of wartime experience, even such highly developed machines as Cone Multiple Spindle Automatic Lathes will surely be improved.

Cone Automatics are now being used to help build instruments of war. But in the peace to come, they will again be dedicated to building a better, brighter world.

CONE Automatic Machine Company, Inc., Windsor, Vermont



. . . to help dispel Dangerous MYTH

BY TELLING America about *specific* aircraft developments *specific wartime jobs*, Roebling is helping dispel the dangerous myth that there must be some *one best* airplane for *all* jobs. Helping America understand what her aviation engineers are really achieving. In recent issues of a popular news magazine, Roebling continued its running story of America's fighting aircraft with salutes to Cessna and North American, just as we will salute each member of the aircraft industry in turn . . .

NORTH AMERICAN spells SPEED . . .

Meet the 'Mustang," the wild horse of the air—and meet the staff of North American engineers who broke it to saddle. One of the fastest, fightin'est craft in the air today, this P-51 has galloped high, wide and handsome over everything thrown against it.

You don't get that combination of speed and stamina in a fighter plane by just thinking about it. You start with fixed equipment and armament specified for a definite war job. If you're as good as North American's engineers, you come up with a mock-up—a full size "model"—in something under a month. That approved, you put in fourteen to sixteen hours a day, seven days a week, for *one hundred* days—and the first experimental plane rolls out for intensive testing, ahead of schedule.

Speed in design, speed in mass-production, speed in the air—from first to last, North American's "Mustang" stands for *speed*, a specific quality for its *specific wartime job*. You can be proud, America—and thankful—for the skill that brought this highly developed fighter plane to near perfection in less than a year! With skill like that in your technicians' ranks, you can look forward to new miracles in the skies of Peace!

CESSNA means SERVICEABILITY . . .

Salute the "Bobcat," Cessna's tough twin engine bomber-pilot trainer—and salute the Cessna engineers who developed her. Not designed from "scratch," despite her name, this AT-17 is a startling tribute to the foresight, initiative and "stay-out-in-front" spirit of the entire Cessna organization.

For as early as 1939, Cessna had begun production of a medium-weight, high performance twin engine cabin monoplane known commercially as the T-50. Equipped with retractable landing gear, flaps and two 225 h.p. engines, the T-50 was ideal for use as a transitional multi-engine trainer—an almost-ready made answer to U.S. Army prayers for a rugged, dependable multi-engine familiarization airplane.

Thanks to the T-50 and the skilled adaptations which followed—the R.C.A.F. "Crane" and our own Army's Bobcat"—the training of U.S. and Canadian bomber personnel was able to leap way ahead of schedule. Today, thousands of 'Cranes and "Bobcats" are in service helping pilots grow into eagles. You can thank Cessna for that, America—and for the ruggedness that *keeps* those trainers in service too. With men like Cessna's engineers in your working army, you can look forward with pride and confidence to the day when you'll take in the skies in the coming "Family Car of the Air".

JOHN A. ROEBLING'S SONS COMPANY
TRENTON, NEW JERSEY
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BREWSTER
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COLGATE
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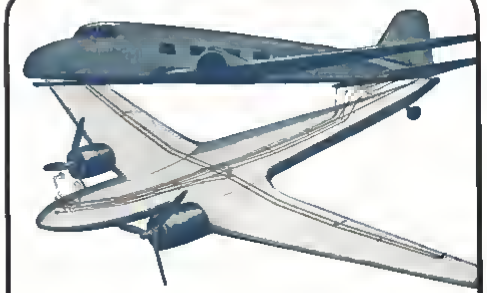


Are you building the airplane "around the control system"?

CONVENTIONAL design of aircraft control systems to date has, in many cases, called for literally building the airframe around the control system.

With the advent of acceptable swaged fittings and the complete pre-installation assemblies of cord and fittings that they make possible, it is worth while for aircraft designers to reconsider:

- In *original installation* does the aircraft design permit of easy application of complete cord-and-fittings assemblies after the ship is nearing completion? In *replacement* of control cords, does the design permit complete assemblies to be pulled through the system—or *is* it necessary to swage one end only and fit the other end by a splice or with comparatively cumbersome portable swaging equipment after pulling it through?

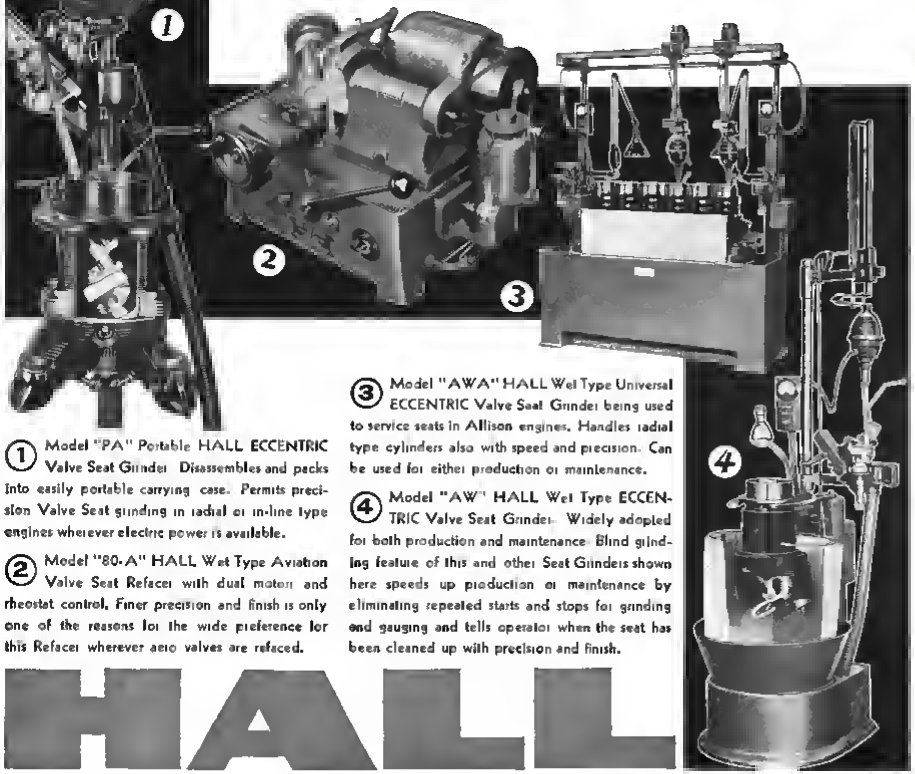
Modifications of conventional design which will permit the aircraft engineer to answer these questions in the affirmative will do much to speed Victory now and to lower maintenance costs when aircraft again take up their heavy and vital peacetime loads.

ROEBLING means Control in the Air!

MAXIMUM AIR POWER DEMANDS FINEST PRECISION IN VALVE SEATING

That's why, in transport, observation or combat, planes with engines whose valves and valve seats have been produced or maintained to HALL standards of precision and finish come through . . . especially when that extra surge of power is required . . . Complete information on request.

THE HALL MANUFACTURING CO., TOLEDO, OHIO, U. S. A.



① Model "PA" Portable HALL ECCENTRIC Valve Seat Grinder. Disassembles and packs into easily portable carrying case. Permits precision Valve Seat grinding in radial or in-line type engines wherever electric power is available.

② Model "80-A" HALL Wet Type Aviation Valve Seat Refacer with dual motors and rheostat control. Finer precision and finish is only one of the reasons for the wide preference for this Refacer wherever aero valves are refaced.

③ Model "AWA" HALL Wet Type Universal ECCENTRIC Valve Seat Grinder being used to service seats in Allison engines. Handles radial type cylinders also with speed and precision. Can be used for either production or maintenance.

④ Model "AW" HALL Wet Type ECCENTRIC Valve Seat Grinder. Widely adopted for both production and maintenance. Blind grinding feature of this and other Seat Grinders shown here speeds up production or maintenance by eliminating repeated starts and stops for grinding and gauging and tells operator when the seat has been cleaned up with precision and finish.

HALL

Why we work against Inspectors

The inspector maintains quality by finding and throwing out substandard parts. **HECKER**'s job is to help make subquality hard to find. We'd be the last to say that better tools, **HECKER** tools, make the inspector's job easier. But we do know that our tools have minimized rejects in many well-known plants.

In *designing and building* tools **HECKER** engineers work with firsthand knowledge of production problems. They know the men and machines of our many regular customers. They know the production problems of our own operations on close-tolerance parts for aircraft. Their extra know-how comes from the production floor where the problems are.

Your big problem may be to speed up your output per machine. Or it may be reduction of rejects. Or both. Whatever it is, let us demonstrate **HECKER** service on your meanest tooling problem. Write A. W. Hecker, 1978 East 66th Street, Cleveland, Ohio, or 517 New Center Building, Detroit, Michigan.

A·W· Hecker

DESIGNERS AND BUILDERS OF TOOLS, JIGS AND FIXTURES — FABRICATORS OF AIRCRAFT PARTS

A MISSION TO FRANCE

With Presents for the Axis

PAGES FROM AVIATION'S HISTORY . . .
Two bombs from a Flying Fortress dropping on a Nazi submarine base at Lorient, France
WORLD WIDE CABLEPHOTO

More and more raids like this are demonstrating the offensive power of the United Nations' Air Forces.. Timed to a split-second, bombs dropped from the bays of Allied craft knock out many an Axis menace to our ocean transport.

The deadly accuracy demonstrated on these missions is accomplished through perfect coordination of plane equipment and crew. Aiding the skilled hands of pilots and bombardiers are numerous precision-built electric motor-controls, each instantly and dependably responsive, each contributing vitally to the success of the operation.

THE EMERSON ELECTRIC MANUFACTURING COMPANY

St Louis • *Branches* New York • Detroit • Chicago • Davenport • Los Angeles

SPEEDIER WINGS

without sacrifice of strength, fire power or protection. That's what the increased use of cast magnesium parts is giving America's planes. This lightest of structural metals, as cast at the Howard foundries, has ample strength for many weight-saving applications in the planes which are inexorably giving the United States full control of the air. Every pound saved means a little more speed — greater aircraft losses for the enemy, and far fewer for us.

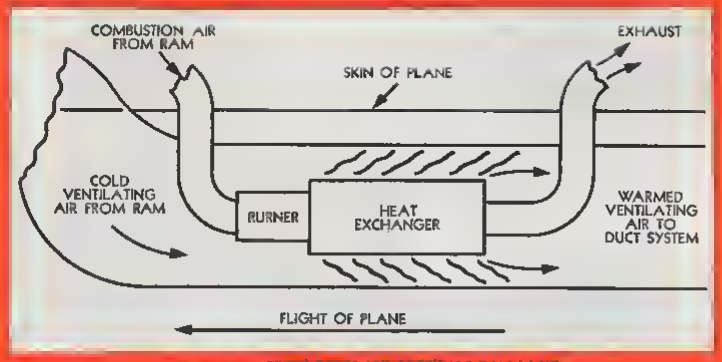
Every week sees an increase in the tonnage of magnesium airplane castings shipped from our new foundry; and tons of aluminum, brass and bronze parts, too — always more bomb racks, bomb parts, gun mounts, turret mounts, landing wheels, nose pieces — to name only a few. Our three foundries are all turning out an endless volume of cast nonferrous parts for ordnance, tanks, tank destroyers, ships, machine tools and essential war machinery.

Howard should be a source of supply of non-ferrous castings for you.

For armament today— for utility tomorrow.

Howard Faundry Company
4900 Bloomingdale Road Chicago

ANNOUNCING—A COMBUSTION-TYPE SERIES OF NEW AIRCRAFT HEATERS



Schematic diagram of new, simplified combustion type South Wind heating method.

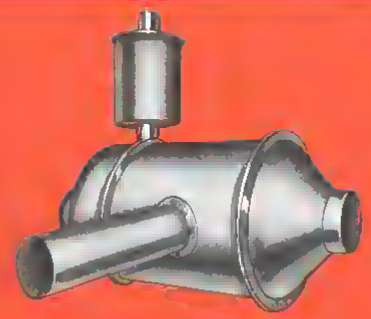
Ram-Air Operation—No Pumps or Blowers—Lower Weight Installed

EMBODYING the results of three years of intensive developments, the South Wind ram-air-operated heater has now been developed in four new models.

First demonstrated to the airplane industry in 1940, this new type South Wind heater eliminates the need for the pumps and blowers which often caused problems of space or weight. Nor are these heaters dependent on engine connection. Only a fuel supply and brief supply of electricity for starting are required.

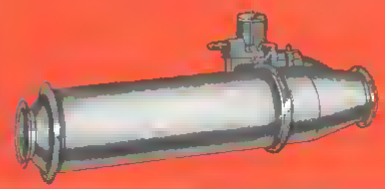
Both ventilating and combustion air supply are provided by air rams. A new pressure-balance principle—developed and proved under laboratory and flight conditions—adds to dependability and assures complete safety. . . . Once more Stewart-Warner's long cooperation with aviation engineers—our world-wide field experience—and our unmatched engineering facilities in this specialized heating field—provide pre-tested and proved equipment to meet the industry's needs.

ARMY (E) NAVY



New Ram-Air Operated South Winds Offered In Wide Range of Heat Output Capacities.

Photographs, weight and space-displacement specifications, as well as heat output data on the four heaters illustrated here are available to persons authorized to receive such restricted or classified information. An unusual latitude of adaptability to heating requirements is provided by these new type heaters.



Another Product of STEWART WARNER

South Wind REG U S PAT OFF **HERMETIC COMBUSTION HEATERS**

HEATER DIVISION, STEWART-WARNER CORP., CHICAGO

West Coast Office: Stewart-Warner Aircraft Heater Engineering and Service, 1273 Westwood Blvd., West Los Angeles, California

Baffles Dirt and Stumps Gremlins, too!

Above, a Gremlin board of strategy known as the Grit-passers, probes for weak spots in one of the many types of Air-Maze airplane engine filters.

The adult Gremlin with the air hammer is vibrating the filter element, hoping it will pack down or separate. The augur-necked Gremlin with the detachable head is chagrined to find his drill unable to pierce the metallic element.

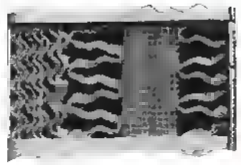
Even backfires are ineffective in destroying an Air-Maze filter, as the blowtorch Gremlin is discovering.

Expert at detecting minute passages with his specially developed proboscis, the midget (baby Gremlin) is receiving first aid after an unsuccessful attempt.

The expressions of frustration to be noted on all these Grit-passer Gremlins are easily explained. The crimped, wire-mesh media, of which Air-Maze filters are constructed, can neither pack down nor separate. There are no plugged areas or thin spots. Each cleaning restores the original efficiency.

If you're interested in efficient air filters that resist vibration, corrosion, exposure or what not, tell the Air-Maze engineers about it. If anyone can fit a filter to your needs, they'll do it—quicker and better!

AIR-MAZE Principle Is More Effective 3 Ways



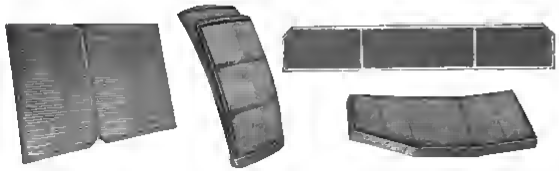
Cross section, one of many filter media designs

HIGHEST PERFORMANCE is obtained by the unique crimped screen wire media. There are no dead areas. Efficiency actually increases as the wires become streamlined with collected material.

LARGE CAPACITY results from the fact that every inch of wire is available for holding dust.

COMPLETE CLEANABILITY is assured by the uniform "channels" through which dirt is easily flushed out. No possibility of progressive clogging.

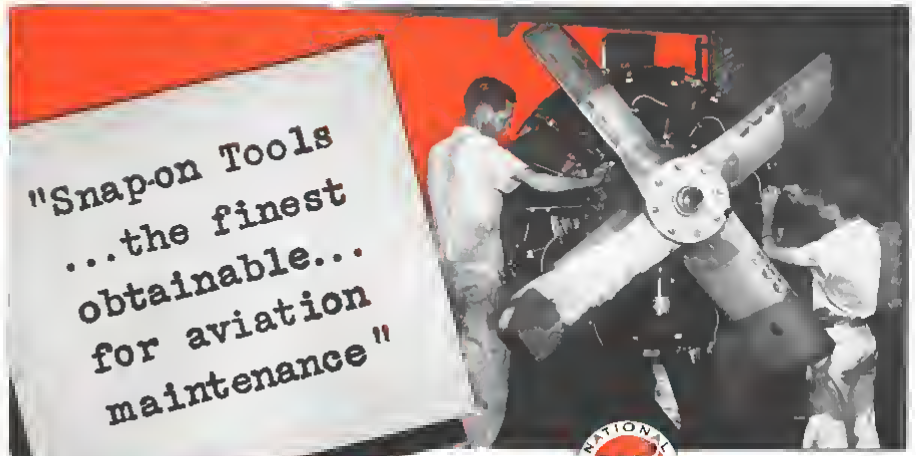
A FEW TYPICAL AIR-MAZE AIRPLANE FILTERS



AIR-MAZE CORPORATION • CLEVELAND, OHIO

AIR-MAZE

SPECIALISTS IN AIR FILTRATION



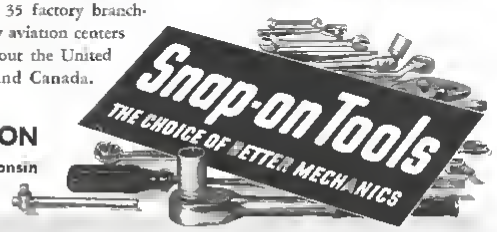
...says NATIONAL AIRLINES

"The Buccaneer Route"

Linking the key cities of the Southeastern defense area from Miami to New Orleans . . . capably serving the war effort in a territory that includes many important training centers of the Armed Forces . . . National Airlines is working its equipment to utmost capacity . . . and holding maintenance to highest standards of safety and efficiency.

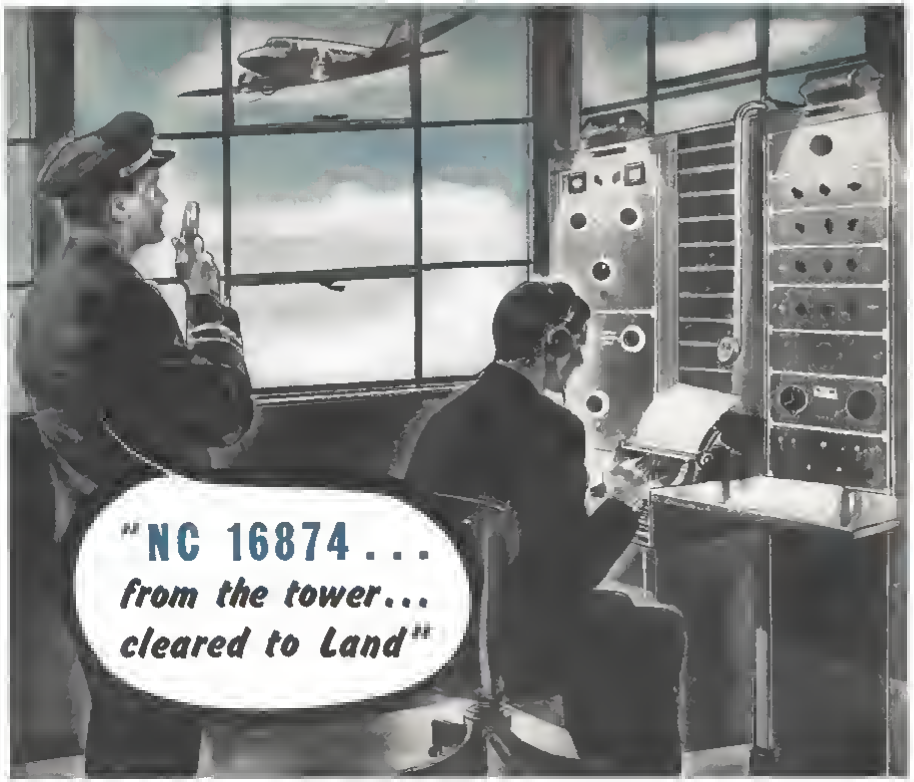
Snap-on tools have long played an important part in National Airlines' Maintenance Operations. Says J. D. Crane, Superintendent of Maintenance, "Snap-on tools are representative of the finest tools obtainable for aviation maintenance, particularly, since the Snap-on Company has designed many of these tools for special aircraft usage. These tools have been purchased in quantity by this company for the use of both mechanics and trainees."

Used in maintenance operations by every major airline . . . the choice of skilled workers in every phase of manufacture . . . Snap-ons have won undisputed leadership as *the tools of Aviation!* The 3,000 tools in the Snap-on line, and Snap-on's direct-to-you service, are conveniently near you through 35 factory branches at key aviation centers throughout the United States and Canada.



SNAP-ON TOOLS CORPORATION

8020-C 28th Avenue Kenosha, Wisconsin



Communications and other radio equipment made by Wilcox are at work to help carry on flight control safely under the increased strain of wartime activity. Present Wilcox manufacturing is devoted exclusively to the Government's needs to coordinate fighting forces on land, sea and in the air with vital communications. Until peace is won, the sign on our door reads, "Uncle Sam comes first."

Communication Receivers
Aircraft Radio
Broadcast Equipment
Control Apparatus
Transmitting Equipment

WILCOX ELECTRIC COMPANY

Quality Manufacturing of Radio Equipment

14th & Chestnut Kansas City, Missouri

What ever happened to the Horse Collar Market?

Who won the World Series in 1935? Who was vice-president under Harding? Of 1431 makes of American automobiles, 16 are known today. How many of the *others* can you name? And what ever happened to the carriage wheel business, and where's the horse collar market?

People, products, markets and methods all succumb to *change* . . . and today that powerful factor of change is doing more to disrupt markets, create new products, and revise production methods than most businesses are even remotely prepared for!

A soap company and a roofing company are operating shell-loading plants. Shipbuilders are building cargo planes. The automotive industry is producing farm machinery, locomotives, air conditioning equipment, and literally hundreds of other unrelated products. Manufacturers are this year spending hundreds of millions of dollars on research alone, and the day this war ends, a new age of production will begin.

Part of this story of change we know first hand, as only specialists can. That part is in the vital and highly specialized field of internal grinding . . . and this much we can tell you on the basis of our own experience with the amazing developments in production that we have seen and helped to produce.

If your business is manufacturing with metal, and if you are planning ahead today for the products you will manufacture tomorrow, the surest way to protect your business against failure from uneconomical production methods is to consult with the leading specialists in machine tool engineering.

Bryant's Consulting Service is available to you at all times. Call upon us now!

Bryant Chucking Grinder Company

SPRINGFIELD, VERMONT, U. S. A.

SEND FOR THE MAN FROM BRYANT

USEFUL CORROSION DATA*

Comparative data assumes new importance in selection of substitute materials

For many applications requiring corrosion-resistant materials, strategic alloys are no longer available. Users must therefore resort to the less restricted metals.

In this situation, the Technical Service Division of International Nickel, welcomes the opportunity to be of service.

Even though your problem may not be concerned with Nickel or its alloys, you are invited to utilize information in Inco corrosion data files.

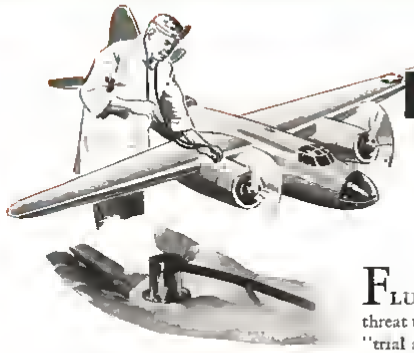
Much of this information has been gathered by Inco Development and Research men as a result of corrosion tests carried out in various plants under actual operating conditions. It applies not only to Nickel Alloys and other corrosion-resisting materials, but also to other metals, including ordinary iron and steel.

In order to supply you with specific data on your particular problem we should know the exact conditions and circumstances involved in each case.

*A **"CORROSION DATA WORKSHEET"** has been recently prepared to simplify the job. If you will request the worksheet, fill it out and return, we will gladly interpret corrosion data with respect to your individual problem. You incur no obligation. For information and assistance please address the Technical Service Division.

The International Nickel Company, Inc.

67 Wall Street, New York, N. Y.



No larger than a silver dollar, the "electric ear" that picks up vibrations

IRONING OUT THE JITTER-BUGS IN BOMBERS!

Martin Research in Vibration and "Flutter" has interesting possibilities in many industrial fields

FLUTTER, bane of aircraft builders and constant threat to test pilots, need no longer be the subject of "trial and error" research, as a result of findings recently announced by The Glenn L. Martin Company. Moreover, in seeking the origin of this deadly vibration which caused planes to shake apart in mid-air, Martin's unique Vibration Department has achieved results of unusual interest to all industry.

Interesting methods and weapons have been developed for this six-year war against vibration. First, was the development of an electric vibrator to set up artificial vibrations in plane parts and structures, simulating actual flying conditions. Coupled with this are the accelerometer and an oscillograph, used to detect and graphically record the vibrations under study.

Both of these devices and use-techniques were products of the Martin Vibration Department. Martin research men are now able, by plotting a graph, to determine the air speed at which vibrations in various plane parts will harmonize to cause flutter and structural breakdown.

If this critical speed is well above the design dive-speed of the plane, there is no danger of flutter. The same devices also provide a powerful weapon against another enemy of extreme speed in planes—compressibility.

Now available to other aircraft companies, this Martin equipment along with Martin graphs and formulas, makes it possible to determine the flutter characteristics of new models during flight test. Thus lives and costly equipment are no longer endangered by flutter, while U. S. Bombardiers are assured of steadier platforms and greater accuracy on bombing missions.

New Horizons For All Industry

In addition to aiding the fight against flutter, Martin equipment is being used to determine dynamic shock and to help overcome motor vibration. This latter field holds far-reaching promise for all industry in the post-war years. Automobiles, trucks, busses, steamships, trains . . . all may be made lighter, more comfortable, smoother-riding. Buildings, housing heavy machinery, will be able to minimize rumblings, vibrations. Delicate mechanisms such as radio equipment will be better mounted for better performance.

Arch-enemy of both structural vibration and resultant human fatigue, Martin vibration research promises to play an important role in building the world of tomorrow.

If the minimizing of vibration will improve your postwar product or plant, tear out this page for your future plans file

The Glenn L. Martin Co., Baltimore, Md., U. S. A.

Martin
AIRCRAFT

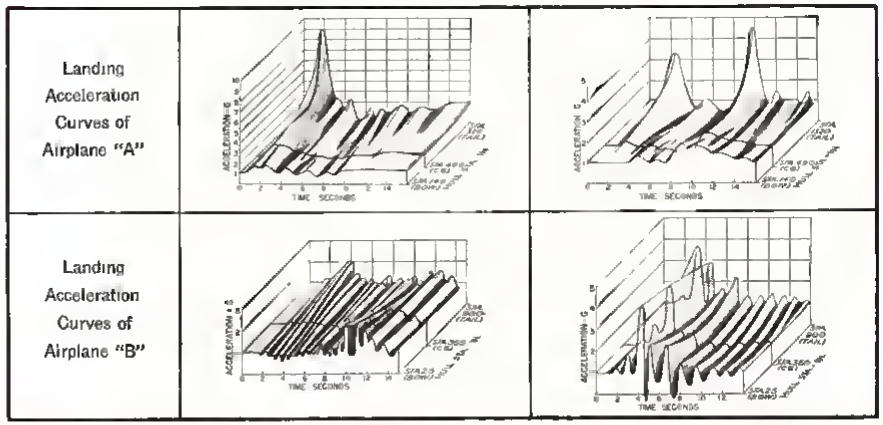
Builders of Dependable Aircraft Since 1909

Member AIRCRAFT WAR PRODUCTION COUNCIL, EAST COAST, INC.

In Action on nose landing wheel equipment records landing shocks, in much the same way that vibrations are detected and recorded.

☆

Accelerometer, at right, amplifies vibrations picked up by little "electric ears" (in foreground). At left is oscillograph which records findings.



New Wrinkles are 3 dimensional acceleration and vibration graphs which tell the story at a glance, end tedious mathematical calculations.

Earned for Excellence by
American Seating Company
craftsmanship!

A new flag ripples from the masthead over our plant. It indicates that American Seating Company men and women, through more than two years of building war materials, have earned this mark of excellence. It proclaims that our tasks have been done with speed, skill and ingenuity.

This emblem signifies that we have earned the approving "well done" of our nation's fighters. And every one of us is proud indeed to wear the "E" badge, and to treasure it as a symbol of our part in Victory

Builders of plywood aircraft wings, spars, tail surfaces, doors and fuselage structures . . . pilot seats . . . tank seats . . . Army and Navy school, chapel and theatre seats and many other plywood and metal structures.

★ **American Seating Company** ★

GRAND RAPIDS MICHIGAN

WORLD'S LEADER IN PUBLIC SEATING

Manufacturers of Theatre, Auditorium, School, Church, Transportation and Stadium Seating • Branch Offices and Distributors in Principal Cities

a Jap's-eye-view of a
WAR WEAPON

SAVE CRITICAL MATERIALS in selection, application and use of electrical equipment

USE NEWLY DEVELOPED METHODS to speed vital war production

KEEP EQUIPMENT RUNNING by proper Maintenance and Repair Service

REPLACE CRITICAL MATERIALS with Micarta and Prestite

SAVE SCRAP by systematic planning and salvage

Write today for your free copy of WartimeConservation, B-3206

When "sunken" ships come sailing back and "crashed" planes deliver another stick of bombs, the Japs must look with awe on the "weapon" that gives these damaged ships new life. This "weapon" is electric welding. By speeding fabrication and repair, this amazing process is speeding Victory

There still remain, however, many places on the production front where the latest welding techniques are not being used to full advantage. Westinghouse suggests that you investigate them immediately

One new process stitches steel together automatically 20 times faster than any other method. Another type of unit requires 30% less critical materials to build, eliminates troublesome arc-blow.

These and other methods of speeding war production and saving critical materials are suggested in the new 100-page book, "Wartime Conservation." Write for your free copy today. Address nearest office or Westinghouse Elec. & Mfg. Co., East Pittsburgh, Pa.

J-21268

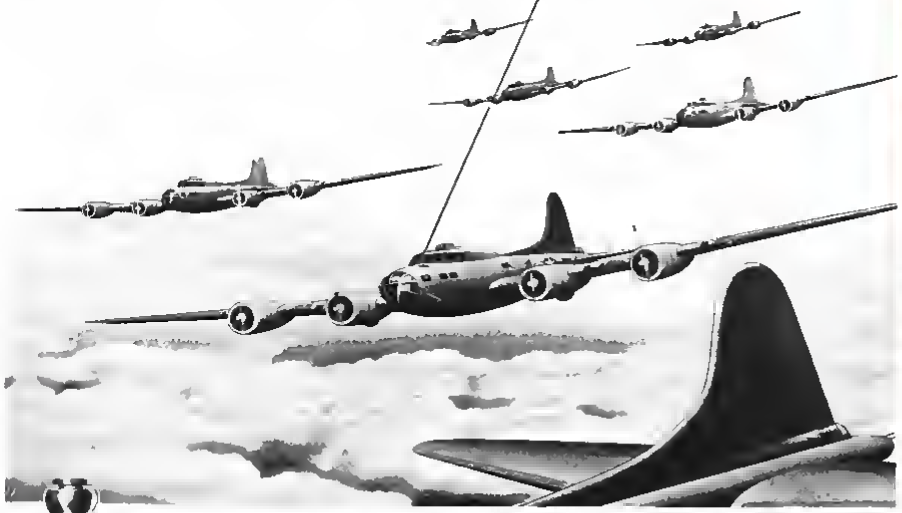
Westinghouse

PLANTS IN 25 CITIES OFFICES EVERYWHERE

C26—Shielded

CHAMPION SPARK PLUGS

which fire at high altitudes and under extremely high pressures in our "hottest" bombers and pursuit ships have exceptional quality of materials, design and workmanship which accounts for their extreme dependability. These very same qualities are inherent in all Champion Spark Plugs.



C26—Unshielded

It takes 112 Champion Spark Plugs to "plug up" a Flying Fortress. And each and every one of them has a real job to do. They fire at a faster rate than the machine guns with which it bristles, and for hours on end, instead of mere minutes. They must fire at pressures and temperatures not encountered in normal engine practice, and they must be so dependable that pilot and crew don't have to give them a thought.

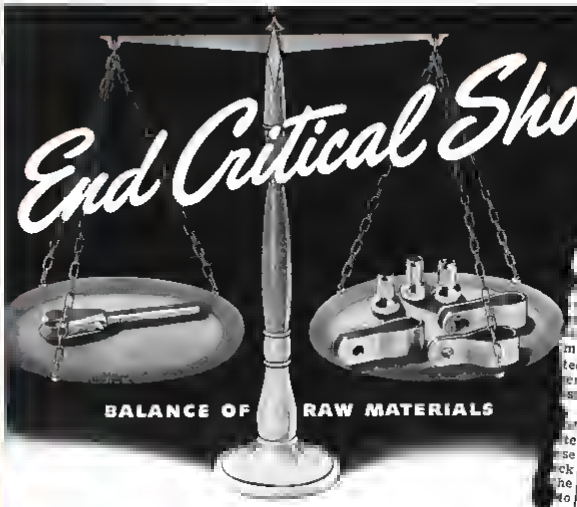
Champion Spark Plugs are filling that rather large order with characteristic distinction. They are being widely used in aircraft engines of every size and type in use by our air forces, and they are piling up records for long life and dependability, hitherto unequalled.

Characteristic Advantages of Champion All Ceramic Insulated Spark Plugs Are:

1. Immunity from heat and chemical reactions.
2. Freedom from fuel, oil, or moisture absorption which causes "shorts."
3. Inherently high heat conductivity with consequent wider range between pre-ignition and fouling.
4. Absolute uniformity of material.
5. Homogeneous structure eliminates air spaces which cause current leakage.
6. Easily cleaned and serviced—no specialized equipment or factory returns necessary.
7. Scientifically controlled manufacture.

THE LOUIS ALLIS CO., MILWAUKEE, WIS.

End Critical Shortages



Note that in spite of its much smaller size, the BALL WITH SINGLE SHANK SWAGED TERMINAL, together with the yoke or rod end for use with it, holds to the rated breaking strength of the cable with which it is used.

Of course there is a shortage in the supply of aircraft terminals. Estimates place it at a high figure—and cumulative. The reason is the critical condition of the steel market plus the fact that there is not sufficient automatic equipment available to produce all the A, B, C, and D Swaged Terminals for scheduled production

You can share in breaking this bottleneck—*you can get earlier delivery yourself*—by adopting TRU-LOC BALL-TYPE SWAGED TERMINALS for your controls. Remember, the shortage of steel—and that BALL-TYPE TERMINALS, plus yoke or rod end, save over 74% of the metal required to make a type C terminal and save over 60% of the stock needed for a type B.

Don't forget, either, that an automatic can turn out five times as many BALL-TYPE SWAGED TERMINALS as either type B or C.

If you need further information, write for complete illustrated folder.

AUTOMOTIVE AND AIRCRAFT DIVISION
6-235 GENERAL MOTORS BUILDING • DETROIT, MICH.

DANGEROUS SHORTAGE AIRCRAFT FITTINGS CAN BE EASED

Ball-Type Terminals Developed by American Chain & Cable Company, Inc. Save over 67% Critical Material and Increase by 500% Productive Capacity of Machines Making Terminals

Chicago, Ill., Dec. 9—The backlog of orders for aircraft terminals types A, B, C and D, threatens to approach a million a month. The supply of steel used for these terminals is critical, a situation which is complicated by another bottleneck—scarcity of additional machine tools and labor to make up this cumulative shortage.

A type of aircraft terminals specifically developed to replace types B and C, is being produced by American Chain & Cable Company, Inc., who operate a special manufacturing and engineering Division devoted to the production of aircraft terminals, cable control assemblies and Push-Pull Controls.

These new terminals are called Ball-Type Swaged Terminals. They are made as a Plain Ball, Ball with Single Shank and Ball with Double Shank. The Ball with Single Shank is more commonly used when the terminal replaces a type B or C. American Chain & Cable Company, Inc. also manufacture yoke and rod end stamped fitting for use with these Ball-Type Swaged Terminals.

Save Steel.

The aircraft industry, and all those who use steel, will be interested in the fact that whereas 1,000 Type C Terminals for 3/8" cable require the use of 188 lbs. of bar stock, 1,000 of the new Ball with Single Shank Terminals for the same cable need only 18.8 lbs. of bar stock and 1,000 yokes for this fitting require only 42.8 lbs. of less critical stock for their stamping—a total of 61.4 lbs.

Save Machine Hours.

Another reason for the interest of war industry in the production of these Ball-Type Terminals lies in the fact that in one 8-hour shift an automatic can produce five times as many of the newer terminals as the same machine can produce of Type C terminals in the same number of hours

AMERICAN CHAIN & CABLE COMPANY, Inc.
BRIDGEPORT • CONNECTICUT

Air Conditioning gives it OOMPH!

This war is being fought with *explosions*. All kinds . . . from block-busters to hand grenades. And don't forget the explosions in the barrels of guns that propel bullets and shells toward the enemy.

It takes a lot of skill to make a good explosion. Air conditioning helps.

The rate at which powder *dries* determines the way it explodes. It must not explode too soon or too late. Hence, special air conditioning . . . with temperature and humidity controlled precisely . . . is used for the drying of powder.

Also, air conditioning protects the lives of workers in munitions plants by providing the safest temperature and humidity conditions.

General Electric is an outstanding supplier of the new improved kind of air conditioning equipment needed for these wartime requirements. It has developed equipment more flexible, more compact than ever before . . . with more accurate temperature and humidity control.

Today this equipment is being devoted to winning the war. After the war, a far better air conditioning will be made available for offices and factories, stores and theatres, homes, hospitals and hotels . . . from General Electric.

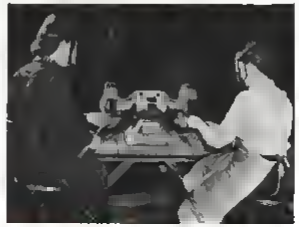
Air Conditioning and Commercial Refrigeration Department, Division 433, General Electric Co., Bloomfield, N. J.

Air Conditioning by GENERAL ELECTRIC

Speeding Deadly "Warhawks" into the Air

Hurrying Giant "Commandos" to take 'em There!

Getting 'em to War Fronts Faster with Black & Decker help. Entire fuselage of each *Warhawk* is crated for shipment to theatres of war. Husky Black & Decker ⅜" Drills like this are used for boring through shipping crate beams on fast, 'round the clock schedules.



Women Team Up at B & D Bench Grinder to keep planes rolling. Operator at left is brushing ⅝" aluminum angles, operator on right is wire-brushing small aluminum rods to remove burrs. A battery of these 10" Bench Grinders keeps material flowing to production lines.

Hundreds of Holes in huge *Commando* noses are drilled in record time with humming Black & Decker Holguns. Because all of the pilot's controls are housed in these massive nose sections, scores of holes must be drilled for the installation of control and instrument panels.

CURTISS-WRIGHT'S newest and deadliest *Warhawk* fighter planes and their giant new *Commando* cargo transports, are filling the air over the world's fighting fronts in swiftly mounting numbers. Playing no small part in this record production are thousands of busky Black & Decker Electric Tools, humming night and day at the Curtiss Wright plants, helping speed the output of these vitally needed planes.

The pictures here show how Black & Decker Tools are doing many important production jobs—jobs that are being done throughout the entire aircraft industry today. They show why aircraft plant production experts say, "You can do the job faster and better with Black & Decker Electric Tools."

This story is another example of the American system of free enterprise at work . . . of close and voluntary cooperation between aircraft builder and electric tool manufacturer . . . of free men uniting their efforts and ingenuity in the common cause of producing more and better weapons to help win this fight for freedom.

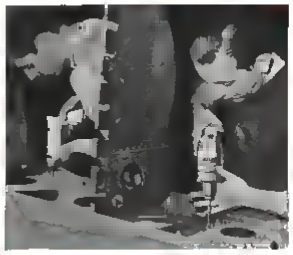
Need Expert Help?

Your nearby Black & Decker Distributor can give you expert help on tooling problems. He is dependable and convenient, as a source of supply or information on any tooling problem you may have. The Black & Decker Mfg. Co., 738 Pennsylvania Ave., Towson, Md.

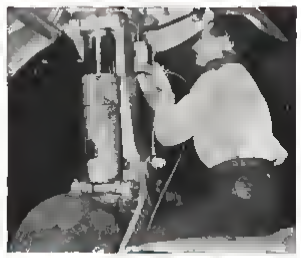
LEADING DISTRIBUTORS EVERYWHERE SELL

Black & Decker

PORTABLE ELECTRIC TOOLS

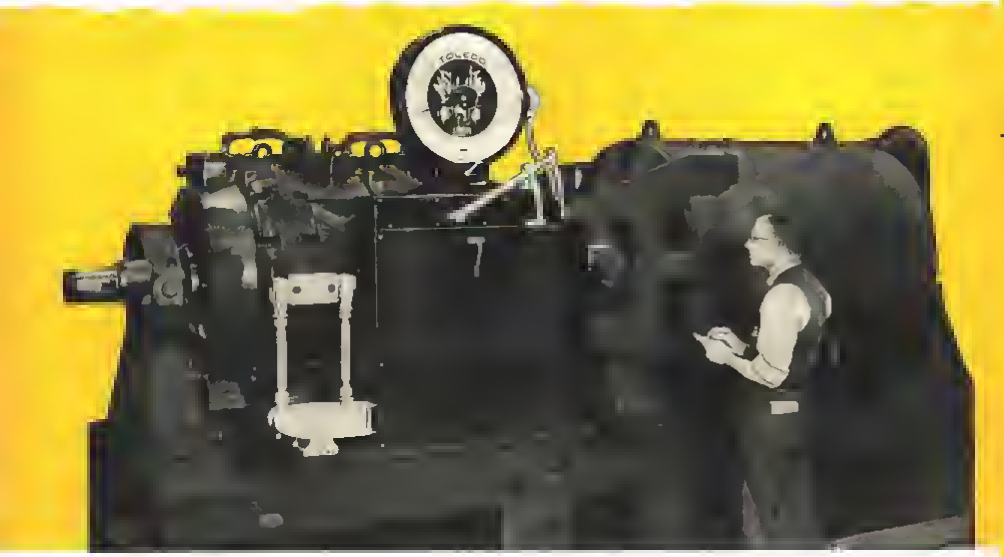


Curtiss-Wright Production Lines are alive with the aircraft industry's most used electric drill . . . Black & Decker's famous "Handful of Power" Holgun. Hundreds of them are used to drill wing sections (shown here) of these deadly Curtiss-Wright *Warhawks*.



from Nose to Tail-Wheel of giant *Commandos*, thousands of holes need to be drilled on fastest schedules possible. Black & Decker Holguns are "musts" in the production of these huge "flying boxcars." Here operator is drilling with Holgun to install a tail-wheel mud guard.

HOW WESTINGHOUSE SERVES THE AVIATION INDUSTRY



4,000 HP ENGINE TESTER

HELPS SPEED DEVELOPMENT OF MORE POWERFUL PLANES

FOR PRODUCTION TESTING

Westinghouse builds stationary and cradle type dynamometers in ratings to meet production testing needs. The factory assembled unit, illustrated, is typical of the smaller sizes. The d-c unit is used for engine starting, and also to apply load—thus acting as a generator to recover power.

A few short years ago, electric dynamometers were found only in a few college engineering and automobile laboratories. Maximum size was approximately 200 horsepower.

Today, this device is playing a vital part in testing giant power plants for Uncle Sam's fighting planes. 4,000 horsepower units are already in service.

This sensational development has been speeded by close co-operation between Westinghouse electrical engineers and the aircraft industry. Because it is far more accurate in determining engine characteristics under load, the electric dynamometer is fast replacing mechanical braking devices for laboratory testing of large engines.

In addition to accurate determination of engine torque, it provides a convenient means of applying any desired constant load, acts as an engine starter, and drives the engine for light-load and special tests.

Westinghouse has pioneered in electric dynamometer development. Our engineers are ready to work with you to meet specific application problems.

* * *

This example suggests the specialized type of service Westinghouse offers to the Aviation Industry. For help on any problem involving the application of electrical power, phone your nearest Westinghouse office Westinghouse Electric & Mfg Co., East Pittsburgh, Pa.

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Westinghouse

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plane talk

ELECTRICAL DEVELOPMENTS, IDEAS, APPLICATIONS FOR THE AVIATION INDUSTRY

WESTINGHOUSE NITRIDING FURNACES for hardening cylinder liners and crankshafts are preferred by a majority of aircraft engine builders because of their accurate and economical results

* * * *

REPLACEMENT MATERIAL TIP laminated Micarta is satisfactorily replacing aluminum for aileron hinge covers, after tests by eastern manufacturer. Further information on request.

* * * *

PRECIPITRON ELECTRIC AIR-CLEANING UNITS are now being used on individual gear-grinders and thread-grinders. Advantages. (1) oil fumes removed and clean air returned to room . . . no additional load placed on air-conditioning system; (2) elimination of oil smudge which reduces lighting efficiency. (3) elimination of injurious effect of fumes on machine operators. More information on request.

* * * *

RECTOX DRY DISC RECTIFIER UNITS FOR ENGINE STARTING are being more and more widely used. Several aircraft manufacturers are standardizing on them throughout their plants.

* * * *

Another Rectox application to watch: use of these low-voltage rectifiers for electroplating equipment. A midwest manufacturer has just placed a substantial order for this purpose

* * * *

PRODUCTION TESTING of engines with electric dynamometers provides high power recovery on test runs. One midwest plant reports that engines on test provided more than 50% of the total power required for their manufacture.

* * * *

A-C WELDING is getting additional attention throughout the aircraft industry. If operating results on new equipment prove as satisfactory as laboratory tests indicate, watch for a big spurt in this field.

Westinghouse

POWER TO WIN

ARMY E NAVY

Your Dollars are Power, too! Buy War Bonds

THE mighty power of dependable Continental Red Seal Engines is serving our fighters on land, sea, and in the air. It is also serving for industry, in the oil fields, and on our farms — serving to keep alight the inspiration and unconquerable "Power to Win" of American Liberty.

Continental Motors Corporation

Aircraft Engine Division

64

AVIATION March 1943

If you question the dependability of Cook "Spring-life" Bellows...

Look to the service they render in the stratosphere

Those who have been there say that *dependability* assumes new meaning at 35,000 feet... This application of the Cook "Spring-Life" bellows automatically compensates for variation in air pressure at varying altitudes and djusts the fuel supply in proper ratio to air ntake. It has the durability to withstand ngine shock and vibration, and the sensitivty to give accurate control and a high factor f safety... This performance is a revelation o designing engineers who have said, "A ellows won't do!" The characteristics and rinciples of construction set forth here exlain *why* Cook "Spring-Life" Bellows *will* do.

Characteristics of Cook "Spring-Life" Bellows

Dependability

y employing metals which are virtually fatigueless and by eeping the flexing motion within the elastic limits of these etals, the expected service life of Cook "Spring Life" ellows is almost unlimited.

Leak-Proof Service

he combination of lock seams and a special method of oldering insures leak-proof service even where operating essures are high.

Corrosion Resistance

ellows of tinned phosphor bronze, high-carbon steel, onel metal and even silver plated bronze soldered with ure tin can be supplied.

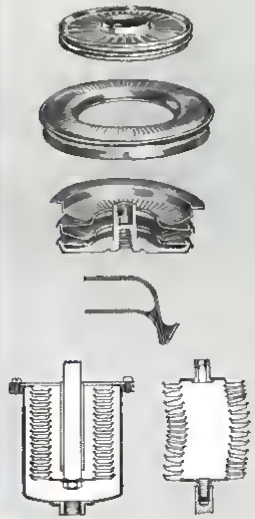
Sensitive Low-Pressure Response

ensitive dimensional response to small increments of pressure can be furnished as required. For example a 2⅜" ellows is available with inside diameters of ¾", 1" and ¼". The travel per flange for each pound of variation in ressure per square inch is, respectively, .0105", .0077", nd .0050".

Uniform Pressure-Movement Ratio

n Cook "Spring-Life" Bellows the pressure-movement atio extends much further above and below the "on-load" osition than in any other type. It responds under load ike a true spring.

This is the "*Spring-Life*" Principle...



The "Spring-Life" principle employs a patented method of construction in which diaphragms or flanges are joined alternately at their inner and outer peripheries. Each flange is characterized by a flat section with radial corrugations and cupped inside and outside edges.

Radial corrugations in each flat section provide greater stiffness or greater resiliency as desired, add materially to the life of the bellows, and permit closer control of flexibility.

Flexure in the assembled bellows takes place at both the inside and outside curved section when pressure is applied.

Diaphragms are lock-seamed and solder is flowed into the groove, eliminating air bubbles and assuring strength.

The action of "Spring-Life" construction is like a long spring under tension. Therefore, when pressure is applied to the outside, it is necessary to mount the bellows in a cup as shown.

This book explains the theory of "Spring-Life" construction, its advantages and data for specifying your requirements as out-of-the-ordinary bellows application. We will send you as many copies as your engineering department may desire.

COOK ELECTRIC COMPANY

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is YOUR office in this fix today?

Mounting office work and a shrinking office staff... more paper work, more accounting, more reports to fill out—and a skeleton office force, loyally struggling to carry the load.

There is an answer: call the Remington Rand technical specialist. He is a veteran with long experience and specialized knowledge of accounting, bookkeeping, tabulating, control systems and general office methods. His suggestions can help you get wider use, and more work, out of your priceless office machines and equipment. For instance:

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▶ He can still furnish your necessary office supplies—file folders, duplicator stencils, typewriter ribbons, carbon paper, and many other supplies—all of dependable Remington Rand quality.

Call the Remington Rand technical specialist. He's as near to you as your telephone. Ten thousand war plants are already using his service to help speed the production of war materials. He may help you win your Battle of Production.

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OUR PLANES MUST GET THROUGH

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Engineered and precision produced in exact accordance with Army-Navy Aeronautical Specifications, this 26 oz Air Filter cleans the air of all contaminants before it reaches the sensitive vacuum operated flight instruments.

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FLUID FILTERS

A 10-oz finely engineered filter that purifies the oil used for operation of Servos of the Automatic Pilot **No tools needed** to dismantle for quick easy cleaning of the Skinner Filter element

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FLUID FILTERS

A midget (6-oz.) does a whole of a job to help prevent ice formation on propellers windshields and in carburetors by removing all contaminants from the anti-icing fluid before it reaches the Metering Fluid Pump

SKINNER FILTERS ARE DEPENDABLE!

If you have filtering problems write for our engineering help—or a copy of our new catalog

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DETROIT MICHIGAN

IF YOU ARE RUNNING A WAR FACTORY

please accept this personal invitation

IF you are engaged in any kind of war production you are invited to make use of a free service which has already stepped up production in hundreds of factories—large and small

Here is how it works. You simply telephone your nearest G-E lamp office, or your Electric Service Company, Electrical Jobber or Contractor. Say: "We want to do all we can to speed production. Will you have a lighting man call and see if he can help us?" The lighting man will carefully inspect your lighting, look for bottle-necks caused by glare or gloom or shadows. He'll show you how to correct those troubles—with the least possible use of critical materials.

You can't *lose* by accepting this invitation. And you may *gain* both in production and in employee morale. So won't you phone today?

TYPICAL LIGHTING TROUBLES WHICH HOLD BACK PRODUCTION

1. **GLARE**—from bare bulbs or wrongly placed fixtures. You may not realize how this is holding back your production.
2. **SHADOWS**—sometimes a worker's own shadow slows up his work. Moving a light fixture often removes this hazard.
3. **GLOOM**—dirt and grease on bulbs and reflectors can cut out *half* your light—and slow down production accordingly. Soap and water work wonders.

For wartime lighting help... Phone one of these G-E lamp numbers or your Electric Service Company or G-E lamp supplier

ATLANTA.....WAlnut 9767 Rad Rock Bldg	CLEVELAND.....CHerry 1010 Williamson Bldg	LOS ANGELES...Michigan 8851 Edison Bldg
BOSTON.....HAncock 1680 United Shoe Machinery Bldg	DALLAS.....LD 224 General Electric Bldg	MINNEAPOLIS...GEnerville 7285 Northwestern Terminal
BUFFALO.....LAfayette 7184 Genesee Bldg	DENVER.....MAin 6141 Merchandise Mart	NEW YORK...Wickersham 2-6300 570 Lexington Ave
CHICAGO.....HArrison 5430 842 S. Canal St.	DETROIT.....CHerry 6910 Book Tower	OAKLAND.....Nlgate 7340 1814 Campbell St.
KANSAS CITY.....Victor 7671 2100 Wyandotte St	PHILADELPHIA...KINgsley 3338 Mitten Bldg	PITTSBURGH.....FAirfax 7911 601 E. General Robinson St.
		PORTLAND.....BEacon 2101 Oregon Transfer Bldg
		ST. LOUIS.....CHestnut 8920 710 N. 12th Blvd.

See your phone book for G-E Lamp offices in other principal cities

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"DOWN UNDER" SECURITY

In the South Pacific, American planes are leading the way in wresting from the Jap his ill-gotten gains. For service in this area of vast distances, planes must have ruggedness, strength and in-built stamina so that there may be no failures on long flights or in combat. • These parts, which must withstand the stresses of battle and time, are logically tough, shock and impact resistant drop forgings. Daily, thousands of these stress resistant drop forged parts are being delivered to aircraft builders the country over by the great new plant of the Kropp Forge Aviation Company. Our output is devoted exclusively to the mass production of drop forgings for the planes of war. • The inquiries of aircraft and engine builders for drop forgings will be given prompt and careful attention.

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It's much more of a trick to make a fine, accurate wrist watch than it is to produce an alarm clock. Similarly, the task of making really dependable and durable midget relays is one that calls for the best that a specialized manufacturer, already accustomed to high standards of quality, can give it—and here Struthers Dunn engineering excels.

As a result, Dunco Midget Relays have established new standards of performance in a wide variety of applications where space is at a premium, and where dependability under exacting conditions of use is essential. They are produced in dozens of standard and special types and sizes for almost any requirement. Dunco Midgets are Underwriter approved.

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Write for the New Dunco Catalog and Relay Data Book

26 Dunco representatives located in every major war equipment manufacturing center throughout the U. S. and Canada are trained to help you in all problems of relay selection and use. Write or wire for address of your nearest representative.

STRUTHERS DUNN, Inc.

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Even on runways hacked out of the jungle

AEROL landings are always safe!

In today's global warfare, Aerol landing gear is serving on such diverse terrain as the steppes of Russia, the scorching sands of North Africa and emergency fields roughly hewn in the wilderness of the South Sea Islands.

In every case Aerols are performing superbly, insuring safe, smooth landings and take-offs that protect the plane and crew.

The splendid performance records now being established by Aerols on world-wide battle fronts are but a continuation of their earlier, peacetime accomplishments. Their success also offers sound evidence that Aerols will do an equally outstanding job in the almost limitless future of after-the-war aviation.

THE CLEVELAND PNEUMATIC TOOL COMPANY
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Also Manufacturers of Cleco pneumatic tools for the aircraft and general industry, Cleco sheetholders, Cle Air shock absorbers for trucks and buses, and Cleveland rock drills for mining and construction work.

AEROLS*

*THE SHOCK ABSORBING UNITS ON AN AIRPLANE'S LANDING GEAR; THE NAME IS DERIVED FROM THE WORDS "AIR" AND "OIL"—THE FLUIDS USED TO DISSIPATE THE LANDING SHOCKS

"Baby" is no bigger than your little finger. "Daddy" is nearly five feet tall.

There are all sizes and shapes in this remarkable family . . . fat ones, thin ones . . . light ones, heavy ones

* * *

These are high-pressure cylinders for holding gases and liquids. One member of the family helped save the life of Eddie Rickenbacker by inflating his rubber raft. Others provide oxygen for stratosphere flyers. Still others put out fires.

* * *

Today high pressure gases are being put to work in hundreds of interesting ways. An outstanding pioneer in this field, Walter Kidde & Company is constantly developing new types of valves, cylinders, and containers to meet the expanding needs of our wartime industry.

Due to increased production, we can promptly fill orders for Kidde pressure cylinders.

* * *

After the war, high pressure gases will play an important part in the more efficient, more productive industry of the future. Perhaps *now* is the time to get in touch with our research and development department. Write: Walter Kidde & Company, 322 West Street, Bloomfield, N. J.

PROTECTS LIVES **Kidde** HIGH PRESSURE GASES | FIRE PROTECTION

IN addition to conventional round leads, the MICROTOMIC "VAN DYKE" Drawing Pencil is made with a flat, rectangular-shaped lead that requires no special chisel pointing.

"CHISEL POINT" LEADS are ⅓ greater in their long dimension than the round lead of the same degree. When sharpened there is 20% more lead at the point of wear. Lines of unvarying width are produced 20% longer. Time out for re-pointing is 20% less frequent...And HI-DENSITY MICROTOMIC Leads, made in the 6 most widely used degrees: 4B—2B—HB—2H—4H—6H, have the advantage of always producing more opaque lines and sharper, clearer blueprints.

MICROTOMIC
VAN DYKE
Drawing Pencils

"VAN DYKE" EBERHARD FABER U.S.A. – 2H CHISEL POINT

THE EBERHARD FABER DRAWING PENCIL WITH THE HI-DENSITY MICROTOMIC LEAD

To help your metallurgist tell "What's in it?"

Here's information your metallurgist should have, if you're working with aluminum alloys. It provides a ready means of answering, "What type of aluminum alloy is it?"

Technical Paper No. 7 presents metallographic methods for examining aluminum alloys. How to prepare a specimen is told in detail, cutting the sample, mounting, polishing and etching.

Metals alloyed with aluminum form a variety of constituents of microscopic size. Systematic methods of identifying them have been worked out by Alcoa's Research Laboratories so that the nature of the alloy and its metallurgical treatment are revealed by the microscope. Chemical etching treatments color the constituents and reveal their form so that they can be identified by the systematic pictorial guide provided in this technical paper.

Your metallurgist may want a copy of Technical Paper No. 7. Write ALUMINUM COMPANY OF AMERICA, 2182 Gulf Bldg., Pittsburgh, Pa.

ALCOA ALUMINUM

NOW a faster, better way to get shrink-fit assemblies

(*Above*) *Operator merely slips chilled plug into heated strut for a permanent shrink-fit assembly*

Deepfreeze Cascade Unit (−120° F.) used as shrinking plug for landing strut

Deepfreeze METAL CHILLING SPEEDS ASSEMBLY OF LANDING STRUTS . . . ELIMINATES "FATIGUE" STRAINS

This is another excellent example of how intense cold (−120° F.) in conjunction with normal heating (+450° F.) has increased the production and improved the manufacture of airplane landing struts.

Formerly the female part of the assembly was heated with torches. This was unsatisfactory, because the torches did not impart a uniform heat nor was the heat intense enough for sufficient expansion. In addition, it was necessary to assemble the units with an arbor press which produced scratches in the mating surfaces... *dangerous future* fatigue and breaking points.

"Production Time Cut in Half"... Completes Operation in 10 Minutes

The barrel of the DEEPFREEZE Cascade Unit is filled with a non-inflammable solvent which does not freeze at −120° F. The plug is immersed in the liquid, while the female part is subjected to an oil bath of 450° F. and expanded .005". The plug is shrunk .0026", making it simple for the operator to insert the plug by hand. Total time for the entire operation is approximately 10 minutes.

The Uses of Deepfreeze in YOUR Plant

Deepfreeze sub-zero temperatures (as low as −120° F.) can help you in the following metal working operations

1—Shrinking of metal for ease of bearing assembly, etc

2—Testing of metals for reaction of sub-zero temperatures to aircraft instruments, etc

3—Treating of metals for prevention of growth or warp in gauges, etc.

FREE ADDITIONAL DATA and proof of the outstanding success of the Deepfreeze method for chilling metals are included in this booklet. Write for *your* copy today.

DATA AND PANT INFORMATION

Shrink-fit assembly of steel plug to airplane landing strut.

Diameter of Plug ..... 3.880" / 3.879"

Diameter of Bore ..... 3.875" / 3.874"

Shrink of Plug .0026" @ −120° F.

Expansion of Bore ..... .0050" @ +450° F.

FORMER DIFFICULTIES

Heating by torches did not impart uniform temperatures. Heating in oil bath alone did not produce sufficient expansion for assembly.

SOLUTION

The Deepfreeze Cascade −120° F. used on plug plus heating of bore results in permanent shrink-fit assembly, speeds operation.

Deepfreeze
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MOTOR PRODUCTS CORPORATION
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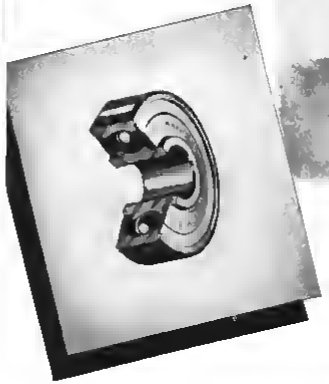

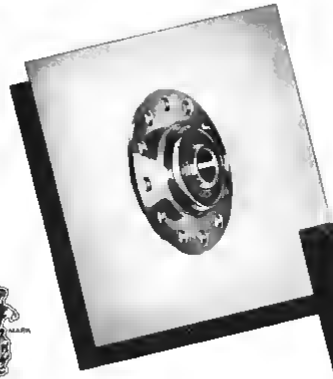

Federal aircraft BEARINGS

THE FEDERAL BEARINGS CO., INC.
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FOR PERFECT TIMING and dependable performance, the outstanding aerial achievement of the opening phase of the Allied African Campaign was the 1,500 mile, non-stop mass flight of 44 Douglas Skytrooper Transports from England to an airdrome near Tunis. The mission of landing paratroops was completed successfully and not an airplane was lost. No other paratroop attack in history has been made over more than a small fraction of the distance! This is but one instance of the whale of a war job Douglas Transports are doing in order that skyways may become peaceways again. Douglas Aircraft Co., Inc., Santa Monica, Calif.

THESE DOUGLAS AIRPLANES ARE FIGHTING YOUR WAR

C-54 "Skymaster" C-47 "Skytrain" C-53 "Skytrooper" A-20 Boston A-20 "Havoc" SBD "Dauntless"

DOUGLAS

Largest Builder of Cargo and Transport Aircraft

MEMBER AIRCRAFT WAR PRODUCTION COUNCIL, INC.

Gulf Super-Quench smashes a bottleneck—

plant ups submachine gun production 100%!

Another example of the greater quenching power of this revolutionary new quenching oil.

Heat treatment of the bolt was the bottleneck in submachine gun manufacture in a large ordnance plant until Gulf Super-Quench was used to quench this part.

To obtain the required surface hardness of Rockwell C-52, it was formerly necessary to carburize the bolt. With Gulf Super-Quench, this hardness is obtained without carburizing, which means a 50% reduction in heat treating time.

In addition, Gulf Super-Quench hardens the bolt through its entire cross section. *Result: bolts of better quality, a 100% increase in production of submachine guns in this plant!*

In plant after plant, this revolutionary new quenching oil is achieving remarkable results. Many parts for the weapons of our armed forces are being made harder and tougher with Gulf Super-Quench than was ever before possible with oil quenching. And yet Gulf Super-Quench has the same minimum tendency towards distortion and cracking that is characteristic only of mineral, fish, and fatty oil quenching media.

Here's the important reason why Gulf Super-Quench is a superior quenching oil. It has *dual action*—a faster cooling rate through the hardening temperature range, and the slow speed of conventional quenching oil below the hardening temperature range.

Gulf engineers are at your service in 30 states from Maine to New Mexico to consult with you on your quenching problems.

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Here is one of many production fronts.....At Solar, continuous schedules are maintained to produce Exhaust Systems for the trainers, fighters, bombers and cargo planes of the United States. Our fighting forces can be assured that Industry at home is "Cutting the Pattern for Victory".

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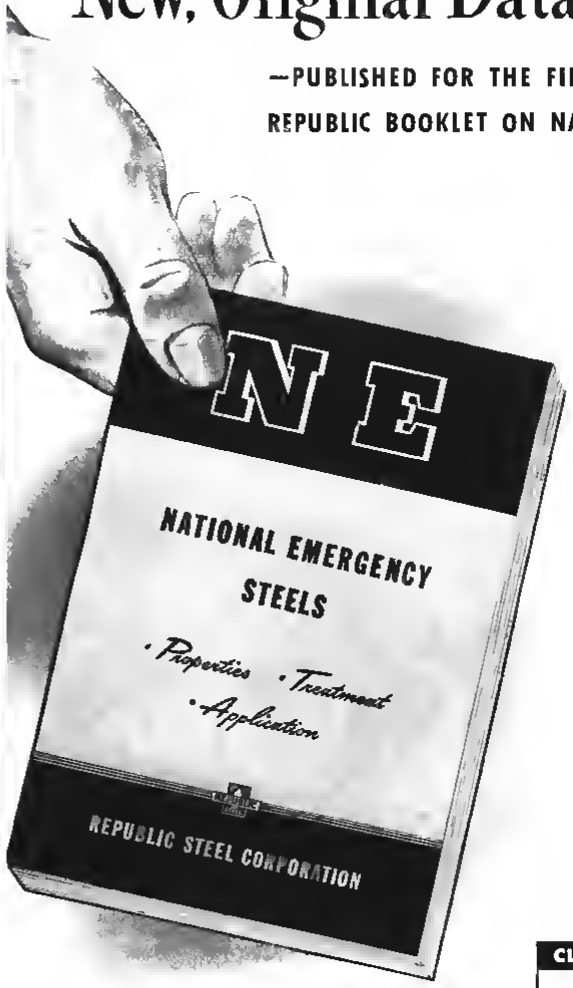
SOLAR AIRCRAFT COMPANY ★ SAN DIEGO, CALIFORNIA

New, Original Data on NE Steels

—PUBLISHED FOR THE FIRST TIME IN THIS HELPFUL REPUBLIC BOOKLET ON NATIONAL EMERGENCY STEELS



Here's just what you've been looking for—70 pages of valuable *new* data on the properties, treatment and application of the NE Steels—in handy, usable book form.

Much of the material in this book—charts, tables and specifications—has been prepared from original research conducted by Republic metallurgists. There's an explanation of the end quench hardenability test and its importance, too.

Republic—long a leader in alloy steel production—was an important factor in the development of the NE series. Now, Republic offers this helpful book on NE Steels as its contribution to more efficient, more productive, faster war fabrication wherever these alloy-conserving steels are applied.

If you have been using alloy steels, you probably are now using NE Steels—or will in the near future. You should have a copy of this book at your finger tips. You'll be surprised at the vast amount of data it will bring you. Printing is now under way, and the book will soon be ready for distribution to *engineers, metallurgists and production executives.* Send your request now to insure early delivery.

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Would you like data on other Republic products—Enduro Stainless Steel, Sheets, Plates, Pipe, Upson Bolts, Nuts and Rivets, Electrunite Aircraft Tubing, Electrunite Boiler and Condenser Tubes? Write us.

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Please send me a copy of your new NE Steels Handbook, which I understand will be off the press shortly

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Textiles—in War as in Peace

World's oldest industry performs modern miracles

WITH ever quickening tempo the friendly hum of the spinning wheel has echoed down the centuries—symbol of a mighty industry.

Its hum is heard today above the din of war.

Capt. Rickenbacker heard it as the lives of his party depended upon a thickness of rubberized fabric.

The hard-pressed soldier on a far-off Pacific isle hears it when he sees fresh supplies and ammunition descending from the sky via friendly parachute.

Adolf Schickelgruber hears it when winter joins forces with the enemies of his ill-clad armies and hastens the day of his defeat.

Yes, man is dependent upon textiles from the cradle to the grave—in peace and in war.

In peace man demands comfort and beauty. In war he must have comfort and protection. The textile industry is coming up to these expectations.

It is developing hundreds of special fabrics for special purposes. It has created clothing for wear, miles high in the stratosphere, and fathoms deep under the sea, clothing to meet the daytime heat of the desert and the bitter cold of its nights, clothing for the tropics and the Arctic, the swamps and mountains—for every climate and every condition.

This is the ninth of a series of editorials appearing monthly in all McGraw-Hill publications, reaching more than one and one-half million readers, and in daily newspapers in New York, Chicago and Washington, D. C. They are dedicated to the purpose of telling the part that each industry is playing in the war effort and of informing the public on the magnificent war-production accomplishments of America's industries.

Modern scientific warfare has forced the development of textiles that were not even thought of a year or two ago: camouflage nets, strong, light, wind-resistant Nylon tentings for the Arctic, heavy Nylon rope for glider towing, parachutes and parachute shrouds, self-sealing gas tanks, panzer hangars, cartridge and powder bag cloths, helmet linings, gas masks, fuses, canvas tops, windshield fabrics and seat upholstery for jeeps, trucks and other motorized equipment, uniforms for all armed services and for nurses, WAACS, WAVES, SPARS and MCWRS. Then there are windbreakers, raincoats, ski-troop uniforms and other items too numerous to mention. The Star Spangled Banner itself is a textile.

The Quartermaster Corps alone has issued specifications for over 300 different fabrics! Add to this the requirements of the Navy, the Air Forces, the various Civilian Defenses, the Red Cross and Lend-Lease and the sum total of textiles required for military and allied uses is approximately 70% of the total produced before the war to meet civilian requirements!

How the textile industry has been able to meet this unprecedented war demand, superimposed upon the industrial and essential civilian needs, is an inspiring story.

First, it stepped up its production to an all-time high. *Textile World's* index of textile mill activity records three successive records for 1940, 1941 and 1942, the period covering the defense program and the first year of the war. This index for 1942 stood at twice that of an assumed normal year. It is noteworthy that this was accomplished mainly with existing equipment.

Second, the textile industry did a job of plant conversion which was a masterpiece of intra-industry cooperation and ideas-sharing.

Third, its technicians developed new and superior fabrics and finishes. Its engineers and production men increased the speed and the efficiency of the entire production machine.

How well all this was done becomes evident when we consider the obstacles to be overcome. Imports of critical fibres have been cut off. There is a shortage of certain chemicals and dyes. There is a high rate of turn-over in manpower and a shortage in experienced labor. It is increasingly difficult to secure machines and repair-parts—just to mention a few of the major problems.

But the textile industry delivered. It has built up an adequate reserve for our rapidly expanding armed services. It is helping to supply the armies of our allies. It is providing for our civilian population—all without giving the war leaders a single moment of serious worry.

Major General Edmund B. Gregory, Quartermaster

General of the United States, in special statements prepared for *Textile World*, and in addresses before textile groups, has stated that the cooperation of the textile industry has been outstanding and that the industry has kept ahead of schedule on all the major types of fabrics required.

General Gregory recently pointed out that of the approximately 234,000,000 yards of combed twill produced in this country in 1942, the Army took about 87%, the Navy 10%, leaving 3% for non-military purposes.

Col. Robert T. Stevens, of the Quartermaster Corps, in a recent address, referred to the output of duck. Production of that vital military fabric was twice doubled in six months, between January and July 1942, he said, and an annual capacity of 600,000,000 yards of all types of duck was made available. "The current rate of production of cotton duck is five times normal," said Col. Stevens, "and 38% comes from converted carpet, plush and upholstery mills. Based upon known requirements, production in this field is fully adequate".

"Fully adequate" is high praise when it refers to duck production. At the outbreak of the war it looked as if there was no possible chance of meeting requirements, at least during the first year. Nor would there have been if other types of mills had not shifted to making this fabric, and if experienced duck manufacturers had not gone "all out" in teaching the newcomers, potential post-war competitors, everything they knew about the manufacture of duck. American industry offers many such examples of unselfish cooperation.

Another outstanding accomplishment, made necessary by the interruption of burlap imports, was the conversion of looms producing peacetime fabrics to the production of bag fabrics. The tremendous demand for sandbags, camouflage cloth, food, agricultural and other bagging, caused a conversion order to be issued for the purpose of raising the annual production rate of osnaburg from 263,500,000 yards to 660,000,000 yards, and bag sheeting from a rate of 488,000,000 yards to 855,000,000 yards. The result of this order, and of the military schedules already in effect, was to put the cotton weaving industry about 88% into war, essential industrial, and essential civilian production.

Plant conversion went on with feverish speed. Carpet looms were swung to blankets and duck, the lace industry turned to mosquito netting and insect netting of which it produced millions of yards. The flat-knitting industry with its tricot machines also is engaged in the manufacture of mosquito netting. The sewing thread industry was converted to the production of combed yarns. What once was the silk industry is now doing a tremendous amount of war work. Those mills which had equipped themselves for throwing Nylon yarns for hosiery are now throwing the Nylon for parachutes. That section of the silk industry that was equipped for weaving rayon fabrics is producing fabrics of high tenacity rayon for flare chutes, cargo chutes and delivery chutes. Many silk and rayon looms that formerly wove clothing materials are now weaving parachute fabrics.

Today practically all Nylon is used for military purposes and the bulk of high tenacity rayon goes into military fabrics.

Above and beyond all the new developments is the gigantic job of producing millions of yards of standard fabrics of many colors and weaves. To produce all the uniform fabrics and blankets is in itself quite a job. The woolen and worsted industry has been doing it magnificently. Tent fabrics and summer fabrics produced by the cotton industry are no less a formidable assignment. I could point to myriad other jobs no less impressive.

The production man can indeed take pride in this record and behind the production man, the textile technician has been working tirelessly. Mildewproofing and waterproofing, so vital in a world at war, are in a new stage of effectiveness. A new process for waterproofing fabrics employs vinyl acetal plastic in place of precious rubber. Textiles that glow in the dark have been perfected for black-outs and other applications. American genius is solving problems many of which seemed insurmountable. Silk, for example, was something the Japanese thought we could never duplicate. A new synthetic textile filament that weighs but one eighth of the finest silk filament threatens to put the Japanese silkworm out of business after the war so far as we are concerned. The post-war possibilities of this development challenge the imagination.

Nor has the primary textile industry been alone in its contribution to the war. The textile machinery industry has been converted almost entirely to war work, save for a few facilities required to relieve extreme bottlenecks and supply essential maintenance and repair-parts.

Similarly, some textile mills, particularly hosiery mills hard hit by the silk and Nylon cut-off, are utilizing their space and skilled staffs to produce parts for war equipment.

The immediate significance of all this is its importance in the winning of the war. There is, however, a post-war implication which is important to the future of America. A mass production textile industry will serve civilians after the war more effectively than ever before, and will put new standards within the reach of millions. A long step has been taken toward that completely synthetic textile industry which some observers see in the future. The tempo of such changes has been accelerated tremendously. The oldest industry in the world now one of America's largest, is showing a youth and vigor that promise much for the future nationally and internationally.

James H. McGraw, Jr.

President, McGraw-Hill Publishing Company, Inc.

Education Alone Will Reduce Absenteeism

INVASION of the aviation manufacturing industry by members of the weaker sex has done much to solve the problem of meeting the labor force requirements of our greatly expanded production program and it must and will do more in the months to come. But it poses new and far reaching problems for management and government.

Plant layouts have been changed in many cases to provide conveniences and comforts heretofore unnecessary. Production methods have been altered to reduce fatigue in certain manufacturing operations, and this has contributed to increased production by men as well as women. More frequent rest periods have been introduced without impairment of production. Housing problems have not yet been complicated because most women workers live at home, but future labor force demands may create new problems in living accommodations.

However, the most serious—and still unsolved—difficulty that has come about since the ladies took to aircraft building is absenteeism, and this is not confined to the women workers alone. Unless steps are taken to remedy this situation it may easily result in the loss of several thousands of airplanes during the remainder of this year.

ANY MAKER OF EXPERIMENTS are being tried to reduce this evil, which in some cases runs as high as 12 percent. Most of the schemes in vogue involve bonuses, lotteries for steady workers, and various forms of additional compensation of one kind or another. These are not likely to be outstandingly successful because they increase purchasing power without providing any outlet for the use of the newly acquired income. More logical is the approach of one manufacturer who, when he discovered that some of his ladies took time off for shopping, persuaded the local department stores to stay open on certain nights so that his workers could do their shopping after hours.

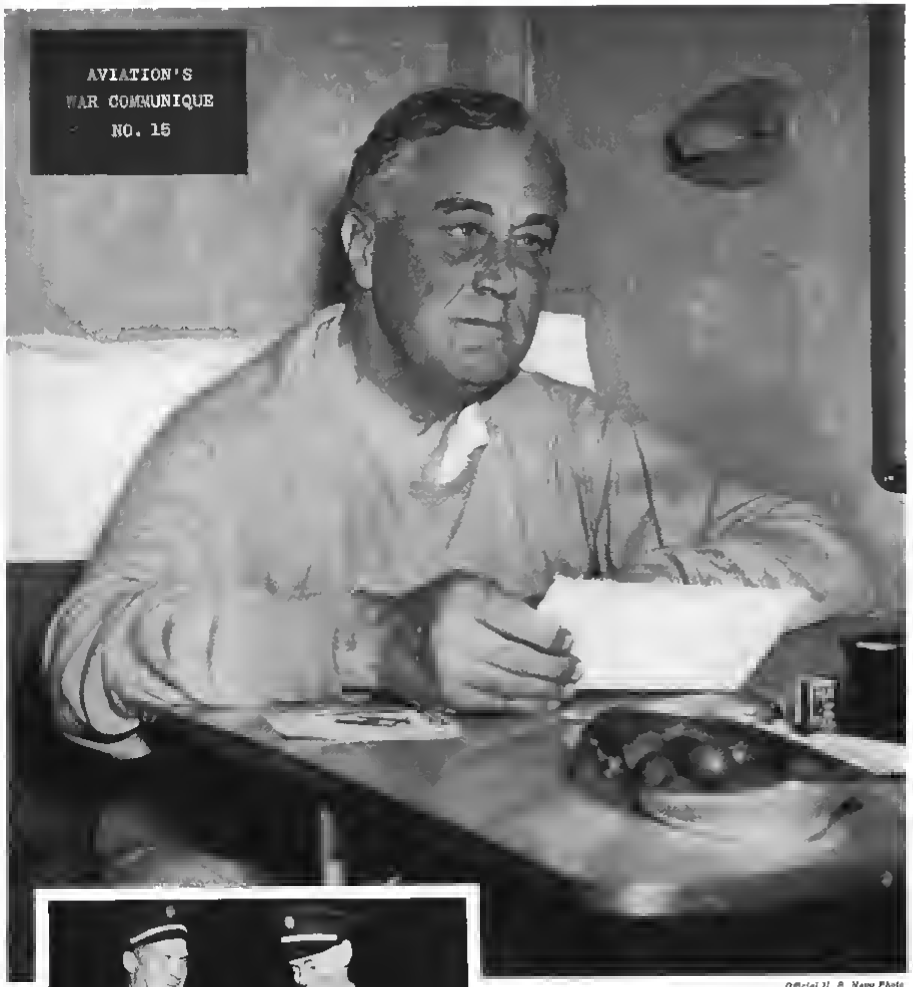
We may as well face the cold hard fact that there are still a few people of both sexes whose patriotism ebbs and flows with the headlines in their newspapers. Another Pearl Harbor would set them on the right track for a couple of months, but recently the war news has been too good and they assume that victory is within easy grasp. Fortunately, this group is small, but it is just large enough to impair the total effort of the vast majority who are working day and night to get the present job done quickly. And the members are concerned less with their earnings than with the material things they can acquire with them. This is not new to this war. It is as old as human nature itself. But it is more serious now because of our record-breaking national income.

THERE ISN'T ANY EASY ANSWER to this situation. Most dangerous of all are the attempts to thwart the impulses of the few by drastic curtailment of civilian goods and recreational activities for all. This policy is unworkable because it imposes penalties equally on patriots as well as slackers. And the innocent outnumber the guilty many times. The result is accelerated war-weariness, which seriously undermines home front and morale and decreases over-all ability of the nation to face the necessary sacrifices that may come later on.

Education will do far more than restriction to correct this evil which may easily mean the difference between success or failure in this year's production efforts—to begin with, a quick but thorough overhauling of the public relations effort of the federal government. Some of the great merchandising minds who are at present without anything concrete to merchandise might well be drafted for this job. And they should begin with the idea that their sales campaign is directed to grown people and not school children. Then, with this as a solid background, industry should improve its human relations job, and we would begin to get somewhere.

Like any other project, the present all-out effort must be sold to every citizen of this country. The existence of absenteeism proves conclusively that this has not yet been done. We will accomplish much more by *systematic selling* of the all-out effort than by trying to *cram* it down the throats of our workers.

Leslie E. Neville



Official U. S. Navy Photo

International News Photo

Capt. Richard W. Viasi (left) and Capt. Howard M. Cane, Pan American *Clipper* pilots who flew Pres. Roosevelt to Casablanca and back, smilingly point out their route on return.

"Flight of the month" honors go three ways—divided between President Roosevelt, Prime Minister Churchill and, last but far from least, American bomber crews participating in the first all U. S. raid on Germany. The President's flight to the Casablanca conference was his first since he flew to Chicago to accept his first nomination in 1932 but he has intimated, it won't be his last. He is shown at work in a Pan American Airways *Clipper* which he used for the trans-oceanic hops. Overland flights were made in TWA-operated craft. Prime Minister Churchill flew to the conference in a Consolidated C-87 *Liberator Express*—the same one, in fact, which he used on his flight to Moscow.

America at War

With first indications that pattern for victory is becoming clear, despite the tremendous job ahead, postwar problems of national and international scope — particularly airline policies — begin to demand attention

THE ENEMY is being badly hurt now. The end is sure, though the time is unpredictable. First hand observation by representatives of the administration shows the Russians murdering the German armies even more effectively than their communiques indicate. British and American overhead attack on Germany and its European production and transportation centers is devastating.

Signs of difficulty, though not necessarily weakness, are plain to military observers of Germany. The speeches of their leaders have the sound of defeat; they no longer display the teutonic bluster. They have stopped their familiar threats of "a thousand to one", they promise their people nothing but hardship and death. They talk of defense, and vow against capitulation, they inveigh against the Soviets, but leave the way open for peace with England and the United States.

Their defeats in Russia are due to exhaustion of manpower, to the rigors of winter, to the length of supply lines. A strong factor, of course, is the amazing unity and fighting spirit of the Russian people. Allied threats of invasions cause the Nazis to spread their forces all over Europe. Especially is this true in Southern Europe, from which an Anglo American attack may come at any time the Axis may be pushed out of Africa.

The Russians, however, fully expect a renewal of Germany's attack in the spring, and are making all preparations to meet it. The Allies expect the Nazis to step up their U-boat war with the coming of better weather. Submarine action against the Allies is now worse than ever despite constant air attack on Nazi construction pens. The United States is pressing its production of escort vessels to the limit, for the submarine is still one of the most "unbeatable" weapons in warfare. Of course it works both ways—our subs are weakening the Japs because they are unable to build merchant ships as fast as we can.

Not the least factor in the pressure on the Germans is the Anglo-American bombardment of Europe. The earlier attack by the Nazis on England was nothing by comparison. The arrogant and vindictive Goering tried to break England by plastering the cities. But the Allied attack is on rail and production centers, on waterfronts, and on every military concentration that can be found. Allied hedgehoppers cover the face of Europe like a pox puncturing locomotives, oil tanks, and trucks by hundreds.

So effective is the air war against Europe that you can find high officials in Washington and elsewhere who believe Germany still may be beaten that way. That there is some support for this theory is shown by the fact that large orders for tanks and certain classes of transport and mobile weapons have been canceled, and the material and manhours have been diverted to

(*Turn to page* 370)

Press Association Inc.

They put the Nazis under the 8-ball. Seen are Boeing B-17 crew members just after participating in the first all U. S. raid on the Nazi's home bailiwick—final proof that Germany will be on the receiving end more and more. Crewmen are left to right, front row: Tech. Sgt. Donald R. Richardson, radio operator; Staff Sgt. Houston B. Brown, right waist gunner; Staff Sgt. Theron S. Tupper, left waist gunner. Rear row: Sgt. John A. Garnot, ball turret gunner; 2nd Lt. Jack W. Mathis, bombardier; Sgts. Calvin W. Owen and Eldon W. Andiss, gunners; Lt. Jesse H. Elliott, navigator; Lts. Squire T. O'Connor and Joseph E. Tregan, co-pilots; and Lt. Harold L. Stouse, pilot.

Outstanding avidance of Canada's new place in United Nations aircraft production pool is given by fact that famed DeHavilland *Mosquito* bomber (above) is being built in the Dominion. This is type that raided Berlin during daylight, interrupting Nazi's "celebration" of 10th anniversary of accession to power. Packard-built Rolls-Royce *Merlin* engines are installed in the Canadian version.

Canada Gains Vital New Production Role

By **RAYMOND L. HOADLEY,** *Financial Editor, "Aviation"*

AVIATION survey shows output of heavier first-line combat planes reaching stride as Dominion fights way up from "step-child" rank.

CANADA'S AIRCRAFT INDUSTRY is just now hitting its stride after having literally forced its way into the United Nation's aircraft pool.

In the early days of the war, the industry toyed around, reluctantly but not from choice, with 20 different types of planes. Many of these, like the *Hampden* bombers, *Lysander* cooperation planes, and the *Stranraer* flying boats, were obsolete before their tooling was completed. Then came Dunkirk, followed by the marriage between the Canadian and American aircraft industries. Things began to happen.

Last year Canada met her own needs in elementary and advanced trainers for the vast commonwealth air training program and even supplied some to her allies. This year, from about July on, Canada will be in full production on a small but diversified group of the best planes of their types that the United Nations have uncovered—badly needed dive bombers, a fast plywood fighter-bomber, Britain's newest four-engine heavy bomber, and a top notch long-range coastal patrol flying boat.

Canada's aircraft program now totals more than one billion dollars, an amount nearly equivalent to the Dominion's total expenditures in World War I. In fact, the United States has more than $250,000,000 worth of planes on order from Canadian companies, a dollar volume as great as the total annual sales of the American aircraft industry a few years ago. And Canada's plane production has been averaging 400 planes a month recently, compared with a possible 40 planes in the course of a whole year before the war. Now that the final stage of conversion to new combat models has been reached, output by number of planes is decreasing. Yet in tonnage the 1943 figures will be far and away beyond all former records.

But to get the real picture of the struggle this Canadian industry has experienced to achieve its present position, it is necessary to hark back, briefly, to the first World War. At that time plants were developed in the Dominion that produced more than 2,500 "stick and string" planes, including the famous Curtiss *Jenny*. Thereafter, the little industry virtually disappeared—until 1923 when Canadian Vickers, Ltd., received an order from the Air Force for eight amphibians.

Three years later deHavilland Aircraft established a Canadian subsidiary, followed by such presently well known plane makers as Fairchild Aircraft, Ltd., Boeing Aircraft of Canada, Fleet Aircraft, and Noorduyn Aircraft. Wright Aeronautical Corp. opened a plant to assemble engines, Cuh Aircraft started producing light planes of the same name, and Ottawa Car & Foundry, Ltd., took up aircraft repair work.

Here was a nucleus of aircraft manufacturers that should have gladdened the hearts of the successive British air ministers. But they were uninterested, and the English aircraft firms looked with disfavor on any overseas expansion. Until shortly before the present war, as Leslie Roberts points out in *Canada's War in the Air*, the industry had to content itself with building heavy-duty planes for bush-flying, light planes for private flying, and repair work. Demands of the Canadian Air Force alone, with its 3,800 officers and men, could not add much in fattening up the infant industry.

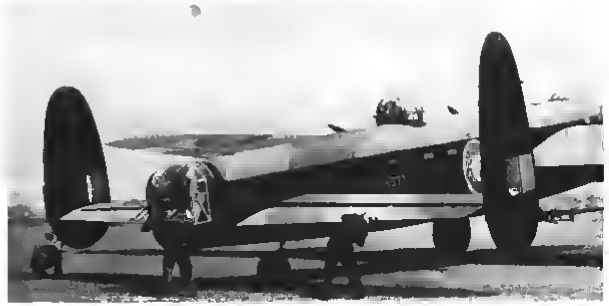
Then in 1936 officials of Canadian Car & Foundry went to London, as the clouds started to gather, for the purpose of interesting British authorities in the production of military aircraft in Canada. But they again found the door closed. The British had no intention of letting the Dominion in on their aircraft program which was still mostly in blueprint form at that time.

Other Canadian companies which pressed their claims both at London and at Ottawa were told that planes would not be required from North America; Britain could look after the ancient needs of all the Empire.

Again in 1938 a British air mission came to Canada, talked vaguely of a "long term buying policy", and held out some hope for a "gradual" expansion of the Canadian industry. Even after Munich the Canadian industry continued to be treated as a stepchild, once in twice removed.

The British Air Ministry, it seems, had little conception of the ingenuity and skill possessed by Canadian aircraft leaders, and British plane manufacturers were only willing that obsolete designs should be sent to the Dominion. Thus Canadian Car & Foundry, which had decided to go ahead and build an aircraft engine in 1938—and completed its tests successfully the following August—got orders to shelve the engine when war broke out. Britain would supply whatever engines the Dominion needed.

Canadian Car, instead got an order for 30 *Hurricane* fighters, promptly secured materials for 300, and saw the original order multiplied many times after the astonished Air Ministry heard that the contract had been finished five months ahead of schedule. Only then did British officials begin to appreciate Canada's great potential aircraft capacity in both brains and brawn. Nevertheless, the "Munich mind" continued to prevail up to the fall of France.



While Canada will build a few less planes this year than last, tonnage will be much greater as the Dominion shifts from almost straight training craft production to larger operational types, such this *Lancaster*, latest of Britain's four engine heavy bombers.

Canada's aircraft industry today employs 75,000—compared to 4,000 before the war—with another 30,000 to be added to payrolls this year. As in this country, women are being employed in increasing numbers. Nearly 80 percent of all new employees at many plants during last four months have been women, who go into air craft maintenance and overhaul work as well as production.

Canadian Car & Foundry Co. finished its first *Hurricane* fighter contract five months ahead of schedule in one of the Dominion industry's first opportunities to build first line combat craft. This speed aided in getting repeat orders, proved that North American part of empire could handle an important portion of Britain's aircraft needs.

War Information Board Photo

The Noorduyn *Norseman* is the only strictly Canadian design craft now in production on order by the United States Produced by Vermont-born Robert Noorduyn, this "flying one ton truck" has not only proven especially valuable for transport work in northern climes, but has been adapted as an outstanding radio training plane

Ralph P. Bell, Director General of Aircraft Production, at dedication of first Canadian-built PBY-5A *Catalina* coastal patrol bomber Being produced by Canadian Vickers, Ltd., this Consolidated Aircraft design is one of the largest planes being built in Canada

Meanwhile, in 1938, National Steel Car had started construction of Canada's largest aircraft plant. Orders were received to build the *Lysander* co-operation plane, followed by parts for the *Hampden* bomber and the *Anson* training plane National Steel Car's president, R. J. Magor—with plans for Canada's future in the air, which seemed most visionary to many authorities at the time—shopped around for a vital part in the production program. Finally he received the go ahead signal on the Martin B-26 bomber, and his company was well advanced on the tooling job when orders came to stop work on the plane.

At long last, it was decided, early in 1942, that National Steel Car would build the *Lancaster*, latest of Britain's four-engine heavy bombers. That, of course, meant further plant expansion to house the huge plane, new orders for materials, and a vast new tooling job.

Pres. Magor died, and the plant personnel became restless at the profiteering delays and changes which the company management did not feel at liberty to explain. The upshot was that the government took over National Steel's big Malton plant last fall, formed a crown company called Victory Aircraft, Ltd., and gave David Boyd, the plant manager and one of Canada's ace production men, the green light to proceed post-haste with the *Lancaster*.

Soon after the war started the commonwealth air training plan was forged to train the empire's airmen and women to supplement Canadian production in Canada Great Britain was to provide the major portion of the training planes while a number of Canadian aircraft makers were assigned the British Avro *Anson* advanced trainer

Then came the fall of France and the stream of engines, propellers, and parts allocated to Canada died to a trickle as did the inflow of British Standard propellers in the fall of 1941.

Canada's underfed aircraft industry had reached the crossroads and quick decisions had to be made. Almost overnight the training plan was geared to North American production. It was dependent no longer on British factories, whose capacities could now be diverted to the all-important task of supplying planes for the coming battle of Britain

Cessna training planes were purchased from the United States, while Canadian plants, under the coordination of Federal Aircraft, Ltd., a crown company, tooled up for a Canadian designed *Anson* trainer powered with the American Jacobs engine Menasco engines, too, were purchased for the *Tiger Moth* trainers Federal has superseded, to date, the production of more than 1,500 *Ansons* in five plants with a cross-section of Canadian industry chipping in as subcontractors for various parts.

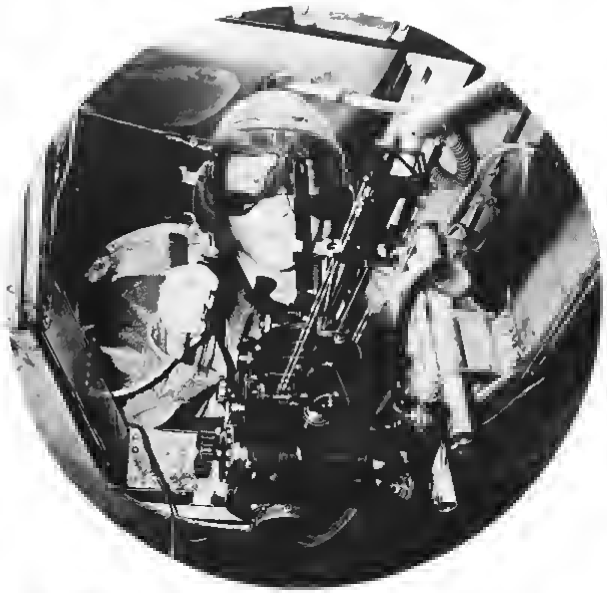
Robert Noorduyn had secured the Canadian rights to make the North American *Harvard* in 1938 Fortunately he had hung on to his highest skilled personnel in peacetime, and, since 1940, Noorduyn Aviation, Ltd., has more than met the Dominion's need for advanced trainer Wright, Pratt & Whitney, and Packard-made Rolls-Royce engines supply power, while instruments, propellers, and parts in great profusion are shipped across the Atlantic to supplement Canadian production.

At first it was planned to have the company produce five different models, but later these plans were scrapped and the plant was linked up with the over-all propeller program for North America whereby it centered all production on one type propeller for the United States and Canada

Results of the decisions made in 1940 when Britain's allies were toppling over like a pack of cards are plainly visible today A large segment of the Dominion's aircraft industry is passing through the final conversion stages to large scale production of the most modern aircraft now used by the United Nations How high production will soar depends, primarily, on the ability to get engines, instruments, and materials from American suppliers For better or for worse, the Canadian aircraft industry is closely allied today with its counterpart in the States.

Approximately 75,000 workmen are employed today, in contrast to barely 1,000 before the war Another 30,000 will be added to the payrolls this year

(Turn to page 342)



Although Canada has literally fought her way into the ranks of operational combat craft producers, the Dominion still carries on a major portion of the empire air training program, turning out bombardiers (above), pilots, navigators, gunners and radio operators by the thousand

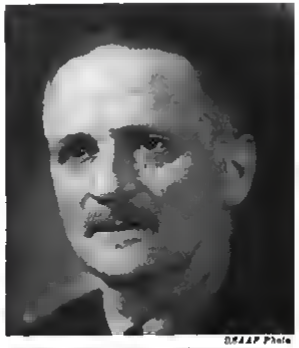
Keystone of Canada's great part in the empire air training program is the *Harvard*, Dominion-built version of the North American AT-6 Rights to its manufacture were secured by Noorduyn Aircraft in 1938.

USAAF Photo

Maj. Gen. Walter H. Frank

USAAF Photo

Maj. Gen. James Doolittle



USAAF Photo

Brig. Gen. Carl Spaatz

The American Doctrine Of Air Power

Part II

By **NATHANIEL F. SILSBEE,** *Major, Air Corps*

Our country devised its own revolutionary air-war theories—and today rigorous battle tests are proving their striking efficacy. Here, the author concludes his revealing analysis of the doctrine with a concise study of our Attack, Fighter, and Air Supply aviation.

HAVING DEFINED America's significant doctrine of air power, we then classified its component parts—Bombardment, Attack, Fighter, and Air Supply—and told when and where each was conceived and credited the men responsible (Part I, page 112, Feb. AVIATION). We designated Bombardment, our first component, as the keystone. Let us now consider the second distinctive function emphasized in American military air doctrine—

Attack Aviation

First, we have seen that heavy bombardment is an example of "pure" air power acting on its own. Attack aviation, on the other hand, works in close cooperation with ground forces. The use of the word "attack" denotes the type of missions performed during the first World War, when assaults against ground troops were initially developed from individual and uncoordinated action by planes mounting machine guns. They harassed and delayed the movements of enemy ground forces.

The 3rd Attack Group, attached to the Third Wing of the GHQ Air Force, was the original attack group in the U. S. Army Air Corps and was a leader in the development of this type of aviation. Among the outstanding men of this group may be mentioned Col. Horace Hickam, a very able and popular officer for whom Hickam Field, Hawaii, was named. Today, a leading enthusiast for attack aviation is Brig. Gen. Nathan Bedford Forrest, chief of staff for Gen. Bob Olds' Second Air Force and great-grandson of the Confederate general of the same name who

USAAF Photo

Brig. Gen. Claire L. Chennault

USAAF Photo

Capt. Eddie Rickenbacker

Lt. Col. Horace M. Hickam, dec.
USAAF Photo

USAAF Photo
Maj. Gen. Harbert A. Dargue, dec.

USAAF Photo
Brig. Gen. William Mitchell, dec.

said a mouthful when he remarked that victory depended on "Gettin' thar fustest with the mostest."

Just as the heavy bomber is an extraordinary extension of the power and range of heavy artillery, so the attack bomber becomes one of the most effective pieces in the ground Army arsenal, with some of the same objectives as the tank. As yet "pure" air power has not had the opportunity to bring about as decisive results as "coordinated" air power, because of the strategic situation. Now that the necessary bases have been acquired and a sufficient quantity of heavy bombers and trained air crews are coming along, a greatly enhanced pounding of Axis industrial and communications centers is in order.

Requirements for the light or attack bomber are very stiff. Because the attack pilot is constantly hedge hopping—dodging terrain features so as to be able to swoop in on his objective with a maximum element of surprise—his range of vision must be as wide as possible. Moreover, the rear gunner also requires an adequate sweep of vision so that he may effectively defend the plane, which must have as much inherent stability as possible, be of rugged construction, and be heavily armed with machine guns and preferably at least one cannon for anti-tank work.

The craft must be capable of carrying several general purpose bombs—100, 250, or even 500 pounders. It must have a high speed to carry out its mission quickly and get away before the enemy's rapid fire automatic weapons can be brought into play against it, and yet it must have a minimum takeoff and landing speed so as to use improvised airfields as near the actual fighting lines as possible. All this adds up to a considerable headache for the aeronautical engineer and designer. It should be mentioned that the land-based dive bomber (such as the Luftwaffe's single-engine Ju-87 *Stuka* and twin-engine Ju-88) is also a highly specialized type used in battle aviation. Although the dive bomber has its use in particular situations, low-level sweeping operations have been found more generally effective.

At present, the best airplane in the world for this type of work is probably the Douglas A-20 *Havoc* (RAF *Boston III*). It is a most versatile plane, having been used by the RAF as a day fighter, night fighter, attack bomber, fighter, and patrol bomber, and by the AAF as a shallow-angle dive bomber at Dieppe. Some new models are also equipped to carry torpedoes, and an improved version is in the works with higher horsepower, heavier armament, and longer range.

A similar RAF ship is the fast, heavily armed Bristol *Beaufighter*, a development of the famous *Blenheim* and *Beaufort* medium bombers. Like the *Boston* it has been used as a specialized night fighter, a long range day fighter, and as a hedge hopping attack bomber-fighter. It is of special interest that *Beaufighters* are now being produced in Australia and are frequently reported in action along with our Douglas *Havocs* and Martin *Marauders*.

From last July to the end of October, hundreds of sorties per day were carried out by the RAF in their *Bostons* and *Beaufighters* against Rommel's forces. Supply depots, trucks, mobile guns, and tanks were repeatedly blasted all along the line. This formidable Anglo-American team of twin-engine fighter bombers was assisted by another RAF-AAF combination consisting of light bomber versions of the *Hurricane II*, called *Hurribombers*, and of the Curtiss P-40D and E, known as *Kittybombers*.

These dual-purpose fighter bombers have several advantages. They "come in" fast and low, the surprise element being strong. They do their stuff quickly and get away before anti-aircraft can get in its full licks. The plane then becomes a speedy, heavily armed fighter, capable of taking care of itself (or anything else) on the way home. Recently they have been using 500 lb. delayed action bombs with great effect, as well as the deadly parachute bombs.

The Middle East RAF air chief, Sir Arthur Coningham, has declared that "those *Bostons* are lethal. Rommel does not like them, and we are dosing the Germans heavily with them right around the clock. They do more damage than dive-bombers, and Rommel does not get our *Bostons*, while we do get his *Stukas*."

A typical report: "Thirty Ju-87's (*Stukas*) escorted by 15 Me-109's, were intercepted by RAF fighter-bombers. Seven of them were shot down, RAF losses were nil." It is also reported that "the low-level frontal attack of the fighter-bomber is far more effective than the dive bomber, since the troops under bombardment cannot guess where the bombs are likely to fall. They are compelled to break up and scatter far afield when under attack, adding greatly to the confusion." Attack aviation scores again.

And not only in the desert. Both RAF Fighter Command and Bomber Command have been using *Bostons* for fast low-flying sweeps across the channel for more than a year, shooting up locomotives, derailing goods trains headed for the Russian front and through Italy to Africa, blowing up small bridges, damaging rail centers, vital parts of small factories, and power stations, and raising hob generally.

More recently these Commands have been augmenting their scope by using *Hurricanes* and even *Spitfires*, and for longer range work *Mustangs* (our North American P-51's) and the new speedy deHaviland *Mosquitoes*. The Army Air Forces are getting deliveries of an attack dive bomber version of the *Mustang*, designated as the A-36. AAF pilots also have been active with the RAF and on their own for several months. Attack aviation has become no small part in the total air offensive now being directed against the Reich.

And don't overlook the neat job attack aviation did in shoving the Japs back from Port Moresby and into the sea at Gona and Buna. First of all, big Boeing *Fortresses*, in unprecedented low-flying sweeps, teamed up with speedy cannon-carrying *Airacobras* and raised merry hell with the Jap supply line. A little later another fast hard-hitting team came into action—Douglas *Havocs* and Martin *Marauders*. The *Havocs* would swoop in and shoot up everything in sight, then he off like a scalded cat. And before the enemy could regain his honorable breath, the *Marauders* would streak through and finish off the job.

All this time Lockheed P-38 *Lightnings*, in as big an aeronautical surprise as the war has yet produced, left their high altitude specialty and did devastating work as hedge-hopping fighter-bombers!

Russia, too, has brought in her contribution. The Soviet Air Force has made a great point of what they called "storming" or assault aviation. The fast, heavily armed and armored Il-2 (*Stormovik*) plane is one of the outstanding developments of the war, as the German panzer divisions can well testify. The Russians regard the *Havoc* (A-20) as possibly our most valuable airplane, and they have made excellent use of a number we have sent them. Also they like our Bell *Airacobra*, with its heavy cannon firing through the nose.

All this adds up to Attack aviation, developed by our GHQ Air Force in 1936. It is safe to say that after "pure" air power has done its work from east, west, and south for a sufficient period, this type of aviation will have a tremendous part to play in the final push against Hitler's "New Order."

Fighter Aviation

Formerly called Pursuit, Fighter aviation was also the subject of much thought and experimentation in the GHQ Air Force. Owing to its complexity, and also the varying points of view, each with a measure of validity, no clear-cut doctrine of fighter aviation emerged comparable to bombardment and attack aviation. Some of the questions are far from settled yet, by this country or any other, after more than three years of a global war in which air power has proved a decisive factor.

For example, what of the single-seater vs. two-seater? In short, should the pilot have a rear gunner to shoot down hostile aircraft? Should a fighter plane be a light fast-climbing interceptor, primarily for defense, or should it be a heavy slugging type, capable of staying in the air a considerable time and able to give and absorb a terrific amount of punishment? Do we need a long range fighter for escorting heavy bombers, or can the latter perform their missions independently? Can we "hit on" an all-purpose fighter which will perform well at all altitudes, though not exceptionally well at any? Or do we need several specialized types?

In the light of the importance of the fighter plane for air defense and as a proved battle-winner in gaining air superiority, these are vital questions. And an indication of American fighter doctrine, as evidenced by current con-

(*Turn to page 379*)

USAAF Photo
Maj. Gen. Mason M. Patrick
Chief of Air Corps 1921-25

USAAF Photo
Maj. Gen. James E. Fechet
Chief of Air Corps, 1926-30

USAAF Photo
Maj. Gen. Benjamin Foulois
Chief of Air Corps 1931-35

USAAF Photo
Maj. Gen. Oscar Westover, dec.
Chief of Air Corps, 1935-38

Building Winning Spirit Into Grumman Aircraft

Official U S Navy photos

An *Avenger* at low altitude work, dropping a "run fish." These capable carrier based planes can be used either for surface torpedo missions or for medium altitude bombing

Grummen *Avengers* in a striking formation above the clouds

By ESTHER H. FORBES

A plant in which "human relations" are lacking between workers and management is a precarious collection of bricks and mortar, men and machines. There is a lesson — not only for the aviation industry but for all industries — in the high morale at Grumman and the underlying reasons for it. This article should be read and reflected upon by all industrial leaders.

SITTING IN HIS OFFICE at the Grumman Aircraft Engineering Corp one Friday afternoon last summer, "Jake" Swirbul was frantically telephoning one number after another. In his shirt sleeves he looked little like a vice president of one of the country's largest airplane factories. As he talked, he sounded even less like one. He was breaking dates for Grumman employees with their wives and fiancees and friends!

That morning, the plant had received word from the Navy that an order for *Wildcats,* originally scheduled for delivery several weeks later, was needed Sunday. Finishing the work by Sunday would mean working around the clock for every factory worker. It was a lot to ask. But after Jake had explained the situation to the men over the loudspeaker system, they quickly volunteered to stay on the job until the planes were ready. And in appreciation Jake offered to make telephone calls for some of the men himself.

When the night shift arrived at work that evening, there was no room for them in the plants, so they turned on the floodlights and assembled planes on the landing field all night long and the next day. Jake, too, stayed on the job with both shifts right through until Sunday, when Grumman delivered to the Navy all the *Wildcats* they had asked for—and 25 percent more.

As it turned out, the cause of the rush order was the sinking of the *Lexington.* The Navy had sent its reserve *Wildcats* to the Pacific to replace those lost with the ship, and new ones were needed as reserves. But no one knew this at the time. They knew only that there was a job to do—and they did it.

A few months later, in December, the day shift arrived at work just as a few stray snowflakes were starting to fall. By afternoon three or four inches had fallen. Anticipating the difficulties that the men might run into driving home in the snow at night, the company dismissed the whole shift at 4:30, two hours early.

This is how things are done at Grumman. The employees know that the executives are always thinking of them. The executives, in turn, know that the employees feel a deep loyalty for Grumman and are more than willing to help the company out in a pinch.

But such loyalty is not born overnight. It is the result of years of cooperation between management and workers. Actually, you never hear anyone at Grumman talk about "management" and "labor" but always about "us." Employer and employee are part of the same unit which is Grumman. They are working side by side, each contributing his particular share.

Largely responsible for this spirit of cooperation is Jake Swirbul. Jake, however, has never organized any "morale program." He knows that what the men and women appreciate most is a genuine interest in them as human beings—that with it they will organize their own activities and that without it no program can be successful. Fortunately, he has a remarkable ability for making friends and an almost unbounded amount of energy. Hardly a day passes that he does not spend hours going through some of the firm's nine plants, giving a word of praise here, lending a hand there, and asking for advice himself. Since Grumman covers an accumulated floor space at least as great as, say, Willow Run, that it is no small job.

Jake believes in taking the workers into his confidence about what the company is doing. After he had flown to England in 1940 to study British production methods, and again after he

(*Turn to page* 374)

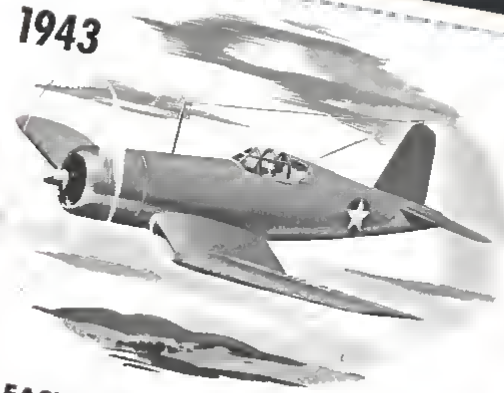
L. A. "Jake" Swirbul, vice-president and general manager of Grumman Aircraft Engineering Corp., addresses *Wildcat* makers at lunch hour. "This month," he is saying, "the Navy needs an unexpected volume of production—and I'm certain you'll even better the Navy's request."

Trail Blazing in the Skies

1924

THE FIRST U.S. NAVY AIRPLANE to be built with duralumin structural members was the Martin MS-1, produced in 1924. These members were formed by Goodyear for the Glenn L. Martin Company. This important work was entrusted to Goodyear because of our previous experience in building duralumin keels for military airships — the first use of this metal-alloy by any private aircraft manufacturer in the United States.

1943

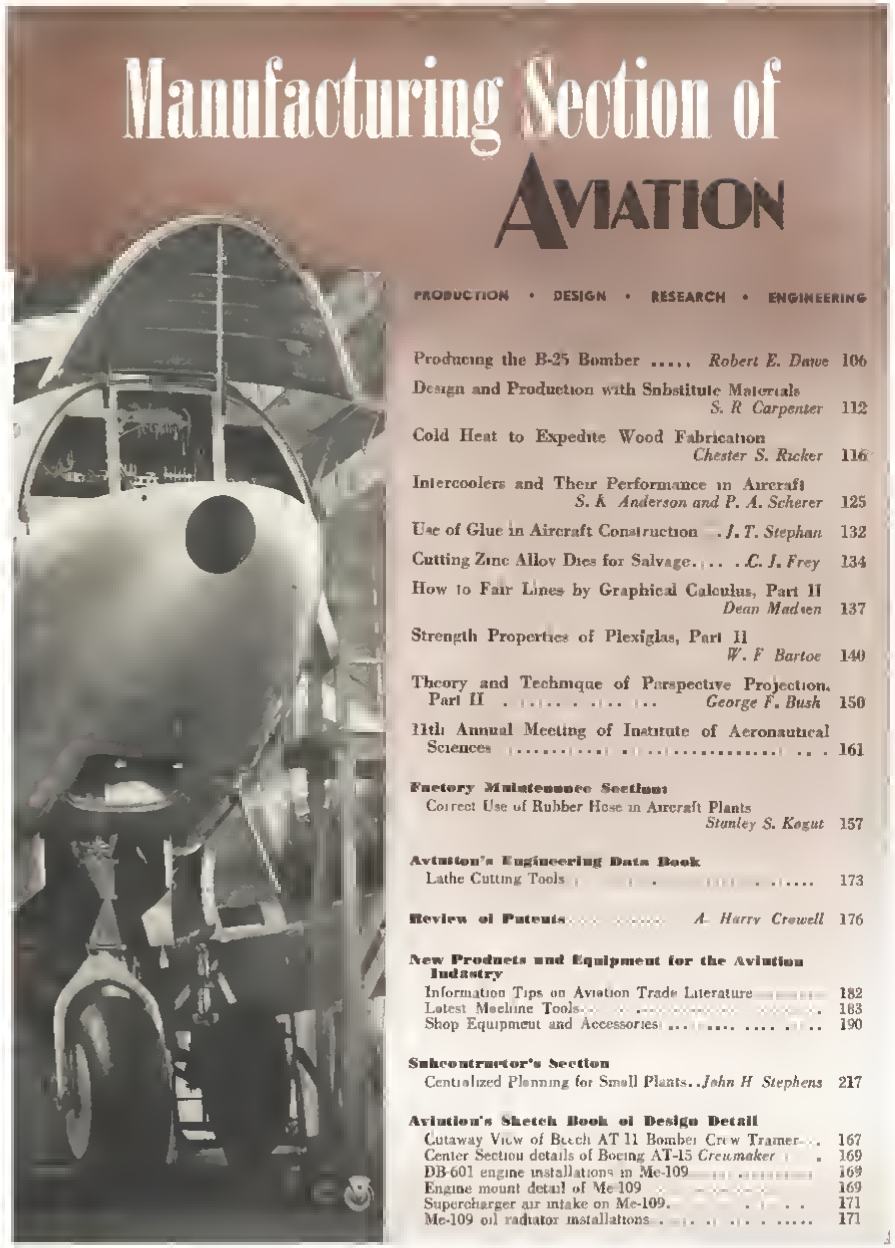


THE FASTEST NAVY AIRPLANE in service today is this Corsair fighter. This airplane is now also being built by Goodyear from specifications of the Chance Vought Division of United Aircraft Corporation, the Goodyear version being designated as the FG-1. Into the building of this all-duralumin ship goes all of Goodyear's long experience in fabricating metal aircraft structures. Although it is faster, longer-ranged and more powerfully armed than any other Navy fighter now in action, its weight is remarkably low for all that is packed in it—proof of superior design and construction.

HOW GOODYEAR AIRCRAFT CORPORATION SERVES THE AVIATION INDUSTRY

1. *By building parts to manufacturers' specifications.*
2. *By designing parts for all types of planes.*
3. *By re-engineering parts for mass production.*
4. *By extending our research facilities to aid the solution of any design or construction problem.*

GOODYEAR AIRCRAFT



Manufacturing Section of AVIATION

PRODUCTION • DESIGN • RESEARCH • ENGINEERING

MANUFACTURING SECTION

Producing the B-25 Bomber

By ROBERT E. DAWE

Factory Manager (Inglewood Div.), North American Aviation, Inc.

North American is one of the leaders in aircraft quantity production and the reason is simplicity and flexibility in its production lines

THE B-25 Mitchell bomber is already a veteran among the combat planes of the Allied Nations air forces. It is widely known, of course, as the ship Maj. Gen. James H. Doolittle used to bomb Tokyo. And it is no secret among Air Forces personnel, that it has been used for high and low altitude precision bombing, troop strafing, night fighting, torpedo bombing, express and personnel transport, reconnaissance, and long range pursuit work.

The B-25's tricycle landing gear contributes to its ability to land on small rough runways, and its short take-off run permits it to get off of ships with ease. On the ground it has unusual stability. But in the air it is officially credited with speed and maneuverability close to that of pursuit planes. These performance features explain most of the uses to which it is put far beyond what is normally expected of a good medium bomber.

At the same time that North American's engineering staff was designing the B-25 for combat flexibility, it also designed the plant for production flexibility in close cooperation with the tool design department. We who are connected with production at North American like to feel that we have contributed somewhat to the combat versatility of the B-25 bomber through our maintenance of flexible production methods in the plant, which in turn has enabled us to incorporate required design changes quickly rather for general improvement of the airplane from a speed standpoint or for performance of specific missions under special conditions.

Fabrication Breakdown

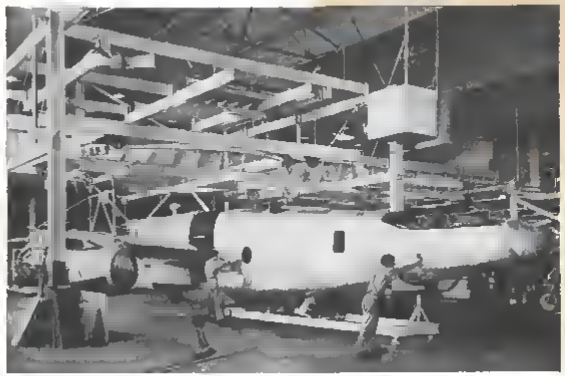
The B-25 *Mitchell* is built according to component breakdown plan in which such components as the fuselage, shell's side, top and bottom panels of three main sections. After fitting the assembly in subassembly jigs these panels are bumped into clustered jigs for the trip through numerous fabrication and installation stations to the master jig. To

Front fuselage section shown being moved into position for joining to center section, so the latter's assembly line, when changes now underway are completed, will arrive at joining position on a new cradle type carrier the wheels of which will run on floor rails. The section will arrive adjacent and parallel to the center section line, on an overhead carrier, be lowered to the shuttle cradle, move laterally to joining position, and before joining will be attached to center section overhead carrier. Shuttle cradle will then return the latter to pick up next front section.

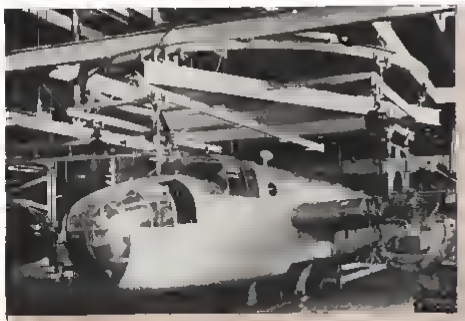
Ready to receive its rear section, engines and landing gear the now joined front and center sections of the fuselage, which includes the inner wings and engine nacelles leaves the overhead portion of the overhead track and is rolled by hand into a combination turntable and storage working station.

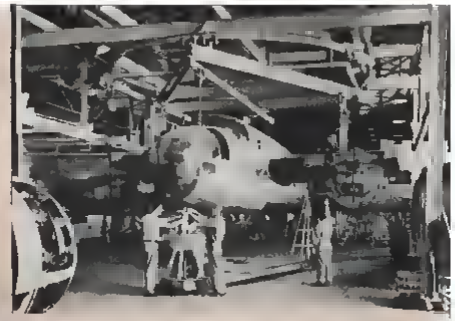
Side, top and bottom panels of front and rear fuselage sections are riveted together in rastered jigs which give easy access for both structural work and initial installations, both of which are done on these lines.

Counterbalanced installation jigs and tools keep them handy, always in the same place, out of the way, and have eliminated one problem that employment of women generally raises—their lesser strength and inability to lift heavy weights for the normal time of a working shift. Squawk, shortage and sign-off sheets are accessible on a clip board hung on this center section of a B-25.



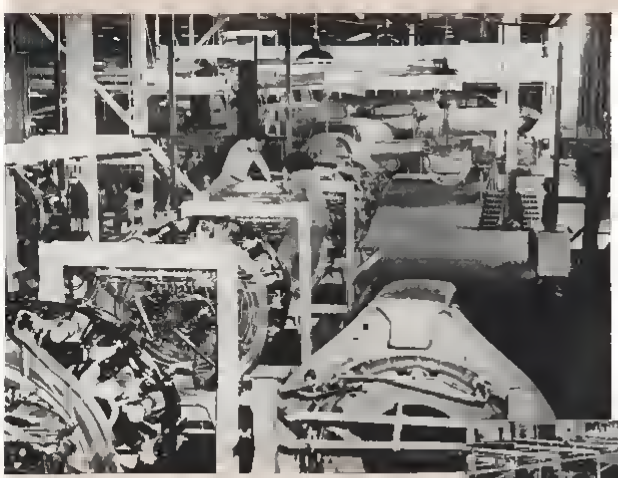
At present, the fuselage rear section is moved into position for joining to the already joined front and center section on a dolly. Changes now in progress will reverse the direction these sections face and the rear section will arrive by overhead carrier, coming directly from its final assembly line which lead straight forward to this turntable elevator station. After joining the virtually complete fuselage will move far right and when clear of the turntable will make a 90 degree turn (in direction most in foreground in picture) and enter the final assembly line.





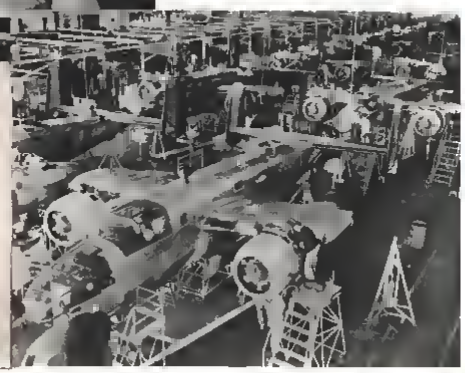
In the turn-table-elevator, the front and center fuselage section is turned to face the engine department. Rolling directly forward two engines will swing into position before the nacelles and their mounts will be attached. Then the section will be turned 180 degrees, to head in the opposite direction, and the tail section will roll from its assembly line beside that of the engines, and be joined in this station. With the engines and tail section attached, the fuselage is raised and a floor carrier is run under it and attached. It will then move forward (toward rear of photo) in a 90 degree turn and enter the final assembly line, in the first station of which the empennage assembly is joined.

The elevator feature of the turn-table station is illustrated here. Under the new arrangement, now in progress, attaching to the floor carrier will follow installation of engines and joining of rear fuselage section and with the ship in a reversed position.



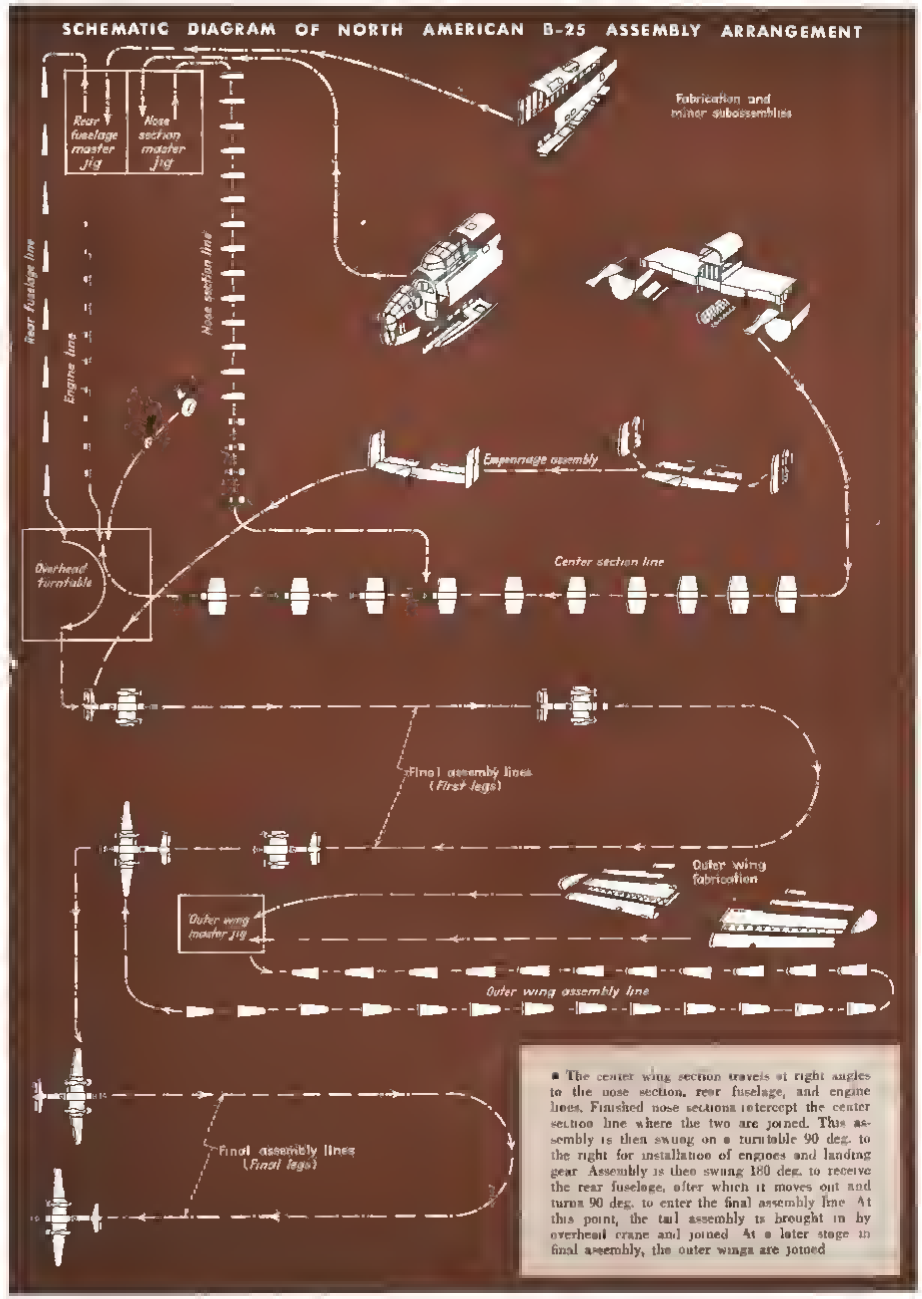
each panel is attached all of the tubing, wiring, cables, radio brackets, switch boxes, interphone boxes, and radio equipment it is possible to install in that stage of completion. This turn enables our men and women to do their work while standing in normal positions, with sides, floors, and ceiling held in an upright position and readily accessible. Considerable time and energy is thus conserved and production thereby expedited.

Four lines of castered, mobile jigs carry top, bottom, right and left side panels of the front section of the fuselage from the tie together, (starting) jigs through six stations to the front master jig. Four other similar lines carry like panels of the rear section through six stations to the rear.



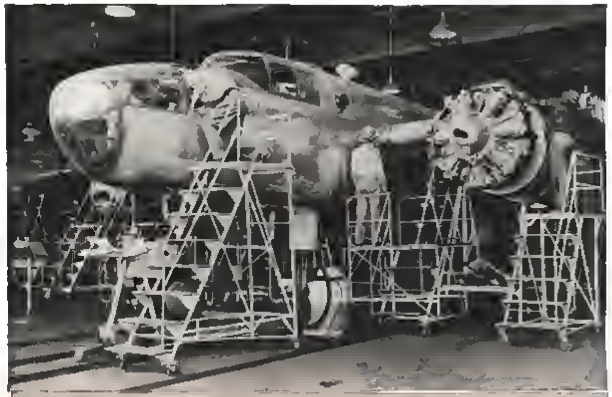
As soon as a new system is completed the engine line will be an overhead carrier line that will terminate at the turn-table-elevator station where engines are attached to the nacelles.

Two of the four legs of the North American B-25 Mitchell final assembly line are partially shown in this photo. In the lower left foreground plane, now almost complete, is about to be raised on tripod jacks, like that at lower right, so carrier can be removed and its own landing gear lowered. Line in background is moving toward rear. When current changes are finished planes will move in same direction but nose instead of tail first, turning at far end to come down second leg of line nose first, as shown above. Throughout its trip over the four legs of the line, under new system, plane will travel nose forward. Overhead carrier line in upper left of photo is the center section line, first 16 stations of which are fabrication and last 12 final assembly and installations.



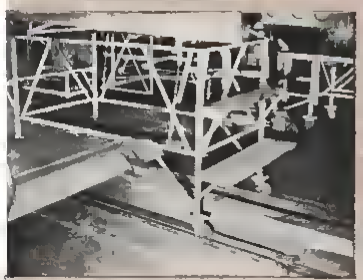
■ The center wing section travels at right angles to the nose section, rear fuselage, and engine lines. Finished nose sections intercept the center section line where the two are joined. This assembly is then swung on a turntable 90 deg. to the right for installation of engines and landing gear. Assembly is then swung 180 deg. to receive the rear fuselage, after which it moves out and turns 90 deg. to enter the final assembly line. At this point, the tail assembly is brought in by overhead crane and joined. At a later stage in final assembly, the outer wings are joined.

AVIATION, March, 1943

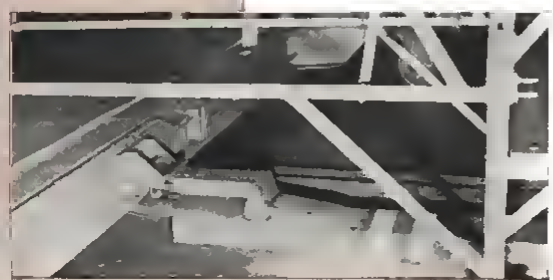


Surrounded by castered working platforms, the B-25 reaches the half way point of its final assembly line still mounted on its floor carrier. Note pawl on apex of carrier frame. Channel iron draglines dogs engage these to push or pull carrier along the line. During second half of the final assembly trip, propellers, outer wing sections, armament and other equipment is installed while plane rolls backward on first "leg" and forward on second, transported on its own wheels. Painting is final operation.

Working platforms are quickly attached to the carrier, or to each other, as North American's B-25 Mitchell medium bomber rolls along its final assembly line. Because stands and platforms are of the "Tinker Toy" type, building on one another, they are added when needed and are quickly removed, thereby lessening the jam around the ship and saving valuable space. Here a workman swings the eyebolt of a mobile stand into position for attaching, with the pin held in his hand, to the I-beam frame of the fuselage carrier.



Front legs of work stand under bomb bay doors fit into sockets on the floor of the carrier and rear legs, mounted on casters running in channel iron guides, straddle forward end of channel steel drag line. When carrier has reached end of station, drag line will slide back (to right) and pick up next carrier, moving it forward through this station. End of dragline indicates this is final powered station.



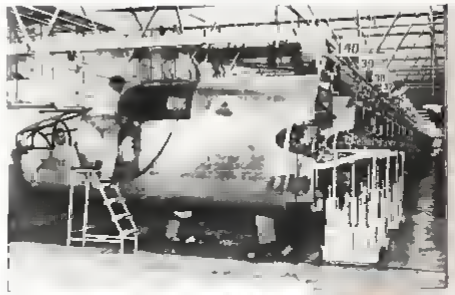
In this close-up of dog and pawl of channel steel dragline which moves B-25s along final assembly line, position of dog and pawl indicates end of station has not been reached. Dragline channel appears to be sliding on floor but actually clears it and is supported by a similar, smaller channel anchored to the floor and over which it slides. Larger wheel in background is on the carrier, its grooved surface riding on an inverted V-shaped track. Note electric outlet on frame of carrier. End of channel indicates carrier is entering or in last station on line.

master jig. Both master jigs are contained with a single steel framework, of the one-story and balcony type, where work is done above and below center lines simultaneously. Both jigs feed directly into overhead-carrier fabrication and installation lines which parallel each other, starting at opposite ends of the master jig structure, to the final assembly line, but at right angles to it.

Overhead Conveyors

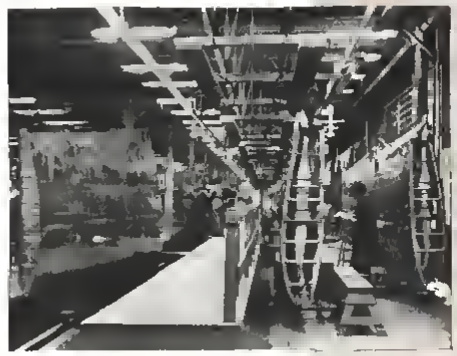
In the master jigs bulkheads are clamped in first, with quick-acting clamps. Next, the bottom, sides and top panels are joined to the bulkheads. Structural and joining riveting proceeds in the master jigs until it is about seventy-five percent complete. Then overhead cranes lift the sections from the jigs and lower them to cradles on the floor. Here carriers are attached and the sections are raised until the carriers enter the overhead tracks of the system where front sections proceed sidewise and rear sections lengthwise, then tail ends forward, to the end of the lines immediately adjacent to the final assembly line.

On the overhead lines fluorescent work-lights are hung at convenient points in each section. They are not removed until the section is completed. Electric current, for both lights and tools, and compressed air lines, are carried in trolleys above the sections, where they are readily accessible but not in the way. Work stands attach between the carriers where they tie the line of carriers into a continuous train, rule free of the floor, and are detached for return to the starting point only when work is finished in the last station of the line.



Fuselage front sections move down an overhead carrier line until they reach the station in foreground where, virtually complete, they will proceed, still on the carriers shown here, to a position beside the center section line. Overhead rails are to be extended. Weights to racks apply tension to control cables being adjusted in last two stations shown. When all equipment for this line is available, work stands that attach to the carriers and ride clear of the floor, will extend between all of the front sections of this line, virtually tying it into one continuous train.

The outer wing panel fuel assembly line is an overhead system, not yet completed, down which wing panels, rights and lefts alternating, will move continuously, going down line at left and coming back on right track. Air and electric lines are on reels in center. Note (below left) that one track is higher than the other for convenience. It rises and falls, from station to station.



Final structural riveting is completed during passage of the sections through the first three stations of these lines, but installations proceed from the first station on to the last. Because of a greater number of installations, front sections pass through forty-one stations while rear sections are being completed in nine.

At the three-quarter point, the bomb-bay and nose section arrives from a separate assembly line, transported on a castered cradle, and is attached to the front section. The enclosure over the pilot's compartment, transported on an overhead carrier, also arrives at this point and is joined to the front section.

Parts for all stations, throughout the plant, are fed from fabrication stocks to conveniently located racks, bins, and shelves adjacent to the stations where they are needed. Workers obtain parts from them as needed, without formality, by merely taking them out themselves. Material Control had assigned them and checked them out before they were transported, by aisle trains, to the small working station storage places.

A feature of the carriers on the fuselage front and rear section overhead lines consists of built-in winches for

(Turn to page 359)

The fuselage rear section assembly and installation line flows toward the turn-table elevator station of the center section line, but at right angle to it. Paralleling it is the engine line, soon also to be an overhead line.

All parts of conversion material for Vultee basic trainers were tested in extended service flight. Plane in foreground shows first types of control surfaces and wing tips made of wood and plastics. Parts now in production conform to original contours shown by plane in upper left.

Design and Production With Substitute Materials

By S. R. CARPENTER,
Assistant Chief Production Engineer, Vultee Aircraft Inc., Vultee Field Division

Vultee has found wide application of plywood and plastic material for basic trainers, thus releasing a considerable amount of aluminum for production of combat craft. Substitute materials have withstood loads far in excess of design loads, have reduced weight, and have proved to be interchangeable with original design materials.

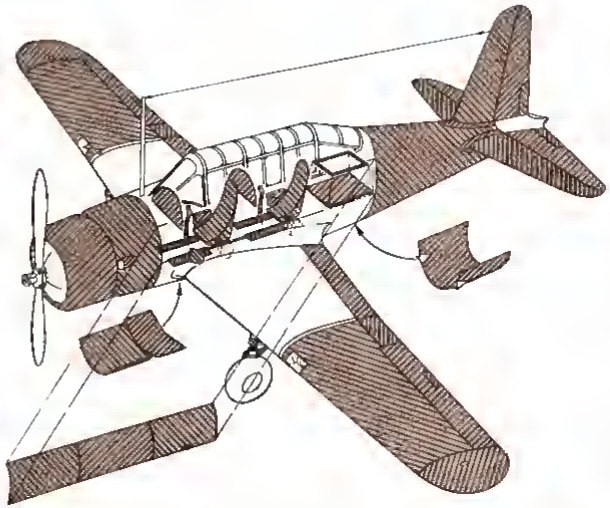
Plastic fairing covers joint between wing panel and inner wing—in same manner and just as efficiently as its metal predecessor on Vultee trainer.

MIDWAY in its mounting output of *Valiant* basic trainers, Vultee's allocations of aluminum alloy began to "pinch out." The nation's limited supply was being absorbed by increasing bomber production.

Having anticipated the trend with extensive research, Vultee was able in less than eight months to convert some 70 percent of its basic trainer design to take advantage of non-critical materials. Throughout this time, actual deliveries were increased monthly.

As the Vultee Field plant's production from substitute materials continues, problems that confronted engineers directing the conversion program can be illustrated by surprising results of these trainers in actual service. For instance, it may be common for Army and Navy cadets to fly BT's with one wooden wing, one metal wing, and part of the original control surfaces replaced by those made of conversion materials.

Unorthodox combinations of this sort have been tried. Planes so assembled fly without impairment of their balanced performance and serviceability.



Substitute materials as applied to Vultee basic trainer. Shaded areas denote sections in which wood and plastic materials are employed. Seats are made of birch plywood. All fairings are formed-plastic material, as are side panels. Wings, empennage, ailerons, and control tabs are wood construction throughout. Monocoque fuselage is also of plywood construction. Basic design of plane is retained, and materials are substituted for aluminum only in those sections where their use does not detract from design performance.

In fact, it was retention of this absolute interchangeability of all parts that became the prime objective in conversion designing. Ultimate replacement needs of the several thousand *Valiants* already in service could not be disregarded. For this reason, complete redesign of the model to take advantage of inherent characteristics of available materials was out of the question.

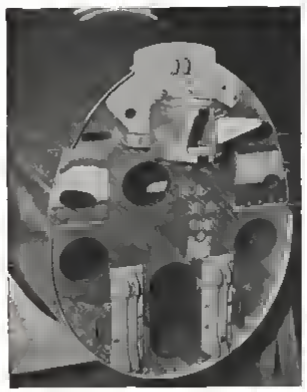
With this in view, and to release a maximum of strategic metals for combat plane output in minimum time, Vultee's conversion program was divided into two general phases. Immediate substitution of wood and plastics was determined upon. This was to be followed and augmented by employment of low alloy steels and magnesium, as soon as production application and supply of these latter could be developed.

Core Required With Wood

Although enough metal to build 400 more Vultee *Vengeance* dive bombers a year currently is being saved by use of wood and plastic in production of Vultee BT's, many factors that appeared favorable in this first phase of conversion have been off-set by pitfalls that required careful circumvention.

To begin with, America's supply of airplane wood is not unlimited. Necessary high standards of selection reduce spruce down to about 10 percent of the

Pilot seats in Vultee trainers are made of birch plywood, with contours formed under heat. Metal fittings attach seat to supporting bars, allowing individual adjustment of height by pilot.



This bulkhead at rear end of monocoque fuselage section of Vultee trainer carries tail wheel and oleo mounting brackets. Tail section is joined to fuselage at this bulkhead.

Prior to switch-over from metal to wood and plastic Vultee experimented with many test applications, such as this one substituting formed plastic for metal in fairing. When tests proved practicability, improvements in tooling and methods eliminated such improper fits as that between fairing and wing shown in this photo.

quantity otherwise available. Even this comparatively small amount has been lugged "frozen" for glider construction.

In fact, designing for conversion to use of wood has become something of a program of finding "substitutes for substitutes." Parts first designed to be made of spruce had to be redesigned to accommodate the characteristics of poplar, western hemlock, and noble fir. Where these proved inadequate, further revision had to be made for use of the heavier douglas fir and birch plywoods. Even western maple has been used to take the brunt of pressure under certain of the plane's fittings.

Another factor of extreme importance to satisfactory use of wood in modern aircraft construction is the special technique required. A number of wood manufacturing concerns exist in the Los Angeles area. Their capacity presumably might be turned with ease to construction of parts for Vultee basic trainers, since standards for woodworking have been established for years and skilled personnel consequently available. But these standards and skills apply only to such commercial products as furniture.

No one worries greatly about strength-weight tolerances in a chair or office desk. In airplane parts they have first consideration.

Interior of wooden monocoque for Vultee basic trainer. Formers are mounted in jig ready for assembly and simultaneously sanded to exact contour by a long abrasive tube. Two skin sections are then joined lengthwise, top and bottom.

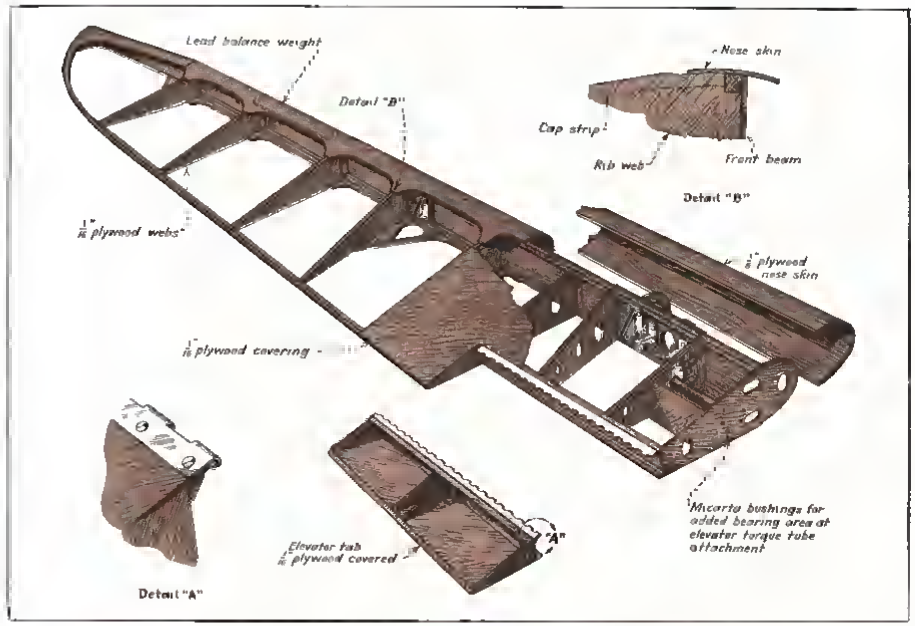
Close cooperation between Vultee and subcontractors producing wooden parts for its planes has proved essential. Both production and tooling engineers are assigned to work with the outside plants. All metal items, such as attachment fittings, are supplied to them, since their equipment obviously is not suited to fabricating hard materials. Fixtures for accurate drilling of parts and checking of their shape and alignment also are provided. Masters of these fixtures are retained by Vultee to assure uniformity of deliveries.

Since, however, wood structures for airplanes differ from other wood products, in that they are designed to utilize fully the ultimate strength of the material, the technique of their fabrication and assembly must be relied upon.

A visual inspection of riveted metal parts suffices to reveal whether or not they are properly put together. But a glued joint in wood is not open to view. If made under specified conditions with prescribed materials and technique, such joints definitely will meet requirements.

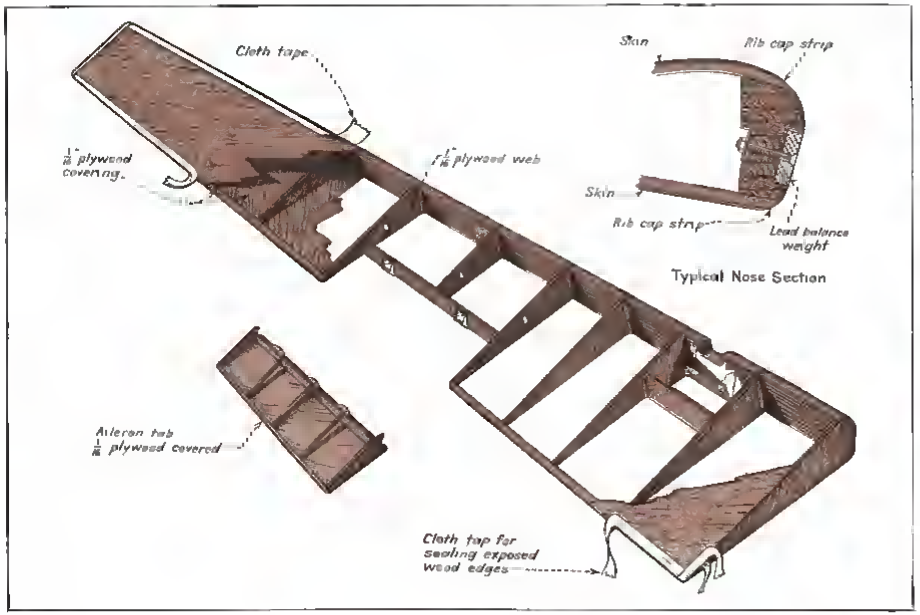
To set up uniform requirements, strict adherence to which produces desired results, Vultee issues to its subcontractors the *Manufacturing Manual for Wood Airplane Parts*.

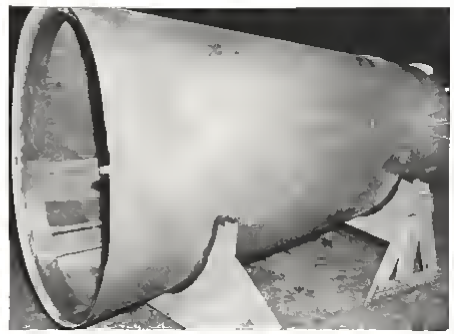
(Turn to page 320)



Structural details of wood elevator for Vultee trainer. Rib webs are of same thickness as skin covering. Nose skin is twice as thick as elevator covering. Note the lead balance weight, steel fittings and micarta bushings for added bearing area.

Construction details of Vultee wood aileron and trim tab. Plywood skin is brushed off at edges with cloth tape. View of forward section of aileron shows use of lead balance weight.





Monocoque section of fuselage, constructed entirely of plastic-bonded plywood, is painted both inside and out to seal required moisture content in wood. Section shown has not yet been painted on inside but exterior illustrates clean, smooth surface—an important characteristic of this construction.

Application of metal formers to plastic side panel for Vultee trainer is accomplished in special jig. Panel former and drill template are positioned against stops and clamped together in jig. First holes are drilled in notched template positions to receive Clern fasteners. After all holes have been drilled, notches allow template to be removed when assembly is released from jig. Clecos hold former securely to panel for squeeze riveting.

Cold Heat to Expedite Plywood Fabrication

By CHESTER S. RICKER

Fabrication of plywood aircraft is now a major war project. How passing high frequency electric current through wood sections polymerizes glue in minutes instead of hours, reducing fabrication time to a minimum.

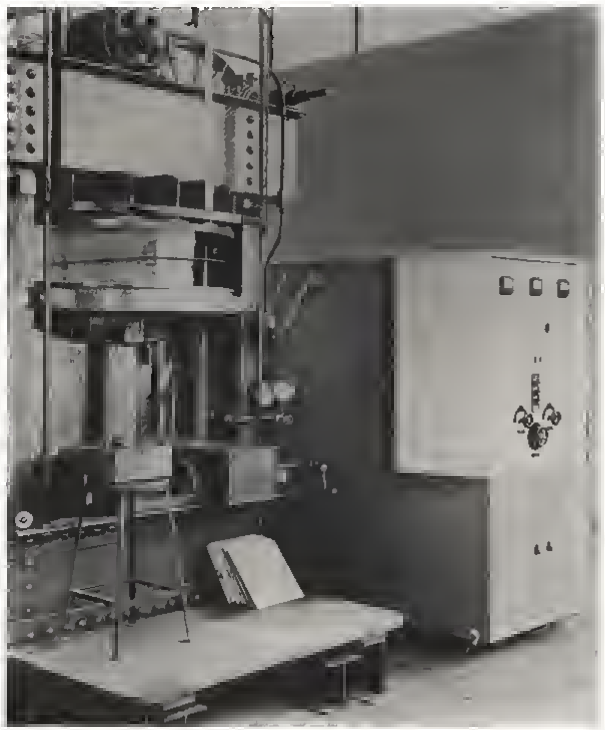


Fig. 1. Typical installation showing Thermex unit attached to standard hydraulic press. Production capacity of press is increased many times by use of high frequency heating.

EQUIPMENT IS NOW AVAILABLE for the application of high frequency electricity to heat non-metallic substances without the use of external heat. For the aircraft industry this means wood laminations and spars can be glued together in minutes instead of hours. When high frequency electricity is applied to wooden parts it causes all the molecules to vibrate, and the resulting friction is converted into heat. What is still more important is that the heating effect is uniform throughout the piece, the innermost molecule warming up at the same rate as one on the surface.

In using this equipment, the thickness of the wood parts to be glued together has no effect on the uniformity of the heating. A greater volume of material will naturally slow down the rate of heating unless the capacity of the electric "heating" unit is increased in proportion. In gluing flat plywood by this method, the bundle may be any thickness, so most practical wood airplane jobs present no problem. Even heavy laminated spars can be glued in as many minutes as it takes hours for them to air-dry now.

The principle of high frequency electric field heating and its application is not new. Used for years by physicians to induce artificial fever, it stems from the radio industry. Initially, the Thermal Engineering Corp. pioneered the application of high power, high frequency electric field heating equipment for industrial use. More particularly they applied it to the drying of tobacco and collaborated with others in the application of this equipment to the killing of insects in grain. They also pioneered in the gluing of wood, installing a large unit in a plywood plant. After that, The Girdler Corp. absorbed the Thermal Engineering Corp. and a fine new plant, modern laboratory, and office were built to house this new Thermex division.

High frequency electric field heating equipment is as technical as the design of a modern radio, and meanwhile its industrial application is as simple and as easy to operate as tuning such a radio. All one needs to know is the correct settings to which the instruments should be adjusted. The Thermex units of smaller size are like large radios encased in metal instead of wood cabinets. They can be moved about the shop like any press or machine tool, then connected to the electric power lines at that point.

Theory of operation

According to Thermex engineers, "In high frequency electric field *heating*, the electrical energy acts upon the molecules of the substance to be heated, causing them to change shape. When the polarity or direction of the electric field is reversed, the molecules again change shape. This takes place with each reversal of polarity. In every cycle there are two reversals - positive to negative, and negative to positive. Frequency is usually defined as the number of cycles per second. With the high frequency provided by Thermex, the molecules are pulled one way and another, several million times per second."

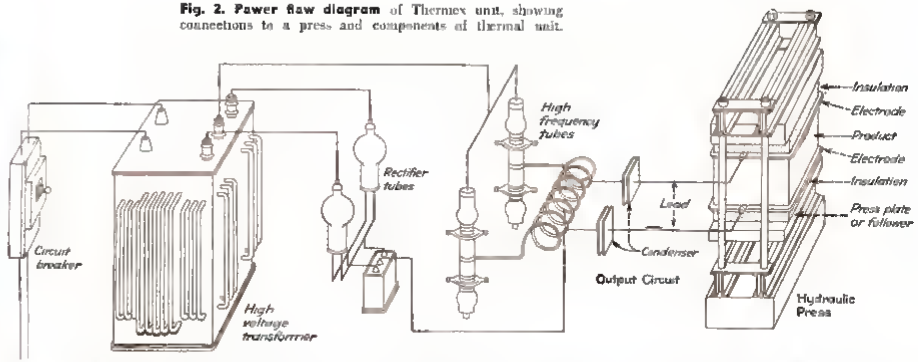
Wood quickly heats up when subject to such rapid vibrations. So does any glue between pieces of wood that are to be bonded together. Furthermore, all this heating is done without injury to the finish or the structural qualities of the wood, yet it quickly sets the glues, especially thermo-setting types such as the urea and phenol formaldehydes which are rapidly and efficiently polymerized by the addition of heat. In other words, the glue can be made to set in a matter of minutes instead of hours. What that means in speeding up wood aircraft production is obvious.

Briefly, high frequency electric field heating does two things: First, it heats non-metallic material uniformly and at a rapid rate; second, it speeds up the chemical reactions as in glue.

Fig. 1 shows a typical unit attached to a hydraulic press which holds the wood parts together until the glue has set.

The power flow diagram (Fig. 2) shows how the thermal unit operates. Regular 110, 220, or 440-v. a.c. electricity enters a high voltage transformer. The high voltage output, still a.c., passes through a bank of rectifier tubes which transform it into pulsating direct current. Then it is fed into high frequency tubes which convert the d.c. energy to high frequency power. This high frequency electricity is fed to the work via

Fig. 2. Power flow diagram of Thermex unit, showing connections to a press and components of thermal unit.



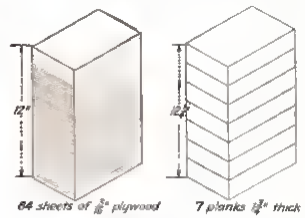


Fig. 5. Uniform heating of stack of plywood or planks from top to bottom can be done only with high frequency electrical heating. Assuming machine of sufficient capacity, greater load can be put in press at a time than with any hot plate, and because of uniform heating, a number of pieces can be fabricated in same time as one.

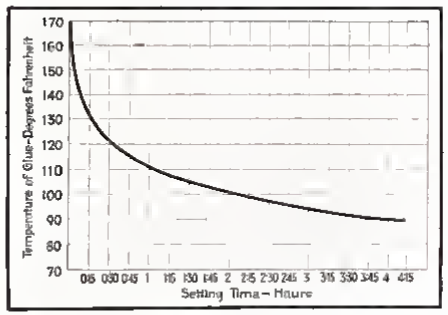


Fig. 3. Setting time of typical glue at various temperatures. Notice how rapidly setting time decreases above 120 deg. The loading time will determine the most desirable temperature.

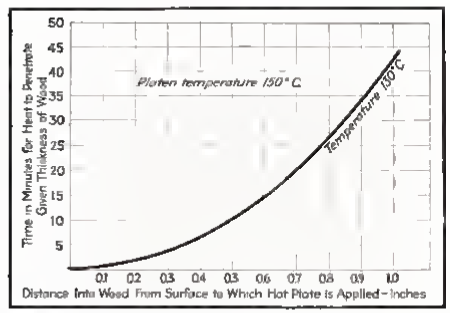


Fig. 4. Curve showing time that must elapse before temperature reaches 130 deg. C. at various distances from a hot plate whose temperature is 150 deg. C.

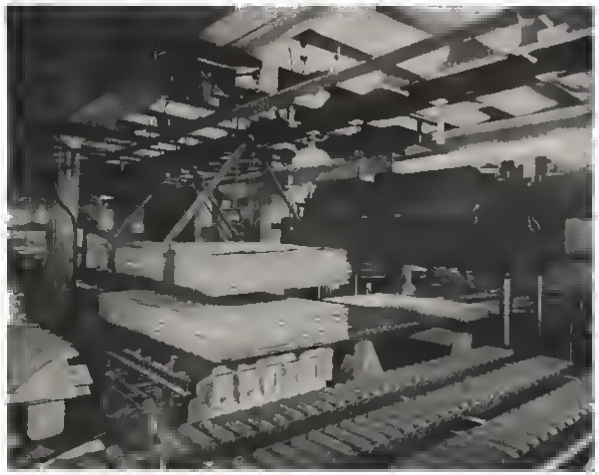


Fig. 6. Loading Thermex-heated plywood press in large Pacific Coast plant. "Hot electrode" is placed in middle of stack of plywood before it is placed in press.

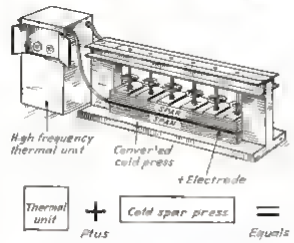
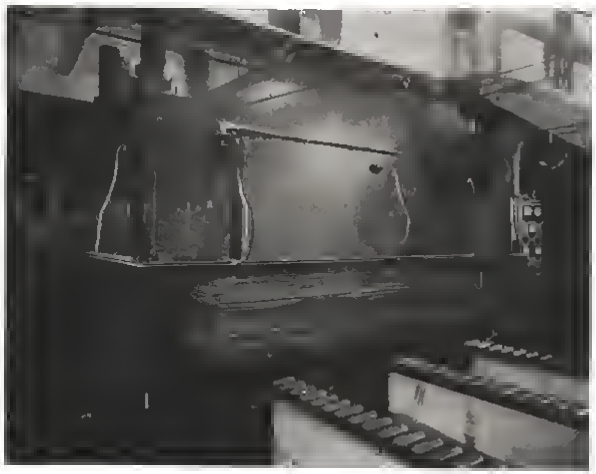


Fig. 7. One high frequency heating unit attached to standard cold press makes possible work of 24 similar presses without heat. Diagram shows relative number of units replaced and factory space conserved.

Fig. 8. Douglas fir plywood panels in press being heated by high frequency current. Note machine is grounded and grounded screen is lowered around work to confine electrical field within press, thus increasing efficiency and protecting operator.



two leads. The leads go to two or more electrodes between which the work is placed.

How It Works on Wood

For years hot plates have been used in making plywood and veneering furniture. Their temperature must be high enough to drive heat by conduction from the contact surface to the glue line. Application of heat reduces the setting time of the glue. Until heat was applied—especially to thin veneers—the same job could be done in two minutes, where it took nearly seven hours before.

Every wood fabricator would use heat if he could, but the thickness of the wood definitely limits that. Wood is not a good conductor of heat, as evidenced in the table shown below.

The higher the temperature, up to a certain limit, the quicker glue sets. Where glue takes 240 min. to set at approximately room temperature it only takes 1.75 min. at 150° F. (see Fig. 3). This means that from a certain size of factory, and [illegible] press or clamp equipment, production can be greatly increased at the cost of plant

HEAT CONDUCTIVITIES

Calories transmitted per second through a plate 1 cm. thick over an area of 1 sq. cm. when the temperature difference between the faces of the plate is 1 deg. C.

Substance	Conductivity
Copper	1.00
Aluminum	0.50
Brass	0.26
Steel	0.15
Brick, common red	0.0015
Asbestos paper	0.0005
Cardboard	0.0001
Wood (fir)	0.0001

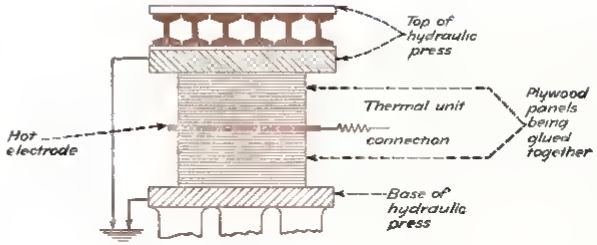


Fig. 9. Diagram showing method of connecting heating unit with plywood press.

and presses can be greatly reduced for a given production when heat is used.

Fact that wood is a poor conductor of heat is the reason for its utility for insulating purposes. But for transmitting heat to glue between two pieces, wood is such a poor conductor that only thin plies can be bonded rapidly with heat applied to the surface. If too high a temperature is applied to the surface it is a well known fact that the surface may be charred, hardened, or scorched. If plywood is not carefully handled, it's structure may be exploded or steam-blistered by the high surface temperatures of hot plates. Fig. 4 shows how slowly heat penetrates wood as the thickness of the wood between the hot plate and measured point increases. This is due to the poor heat conduction of the wood. That is why wood has always been used as a good heat insulator.

The contrary is true with electronal field heating. It is not limited by the thickness of the wood. Neither does it damage the surface nor the structure of the wood. Since most glues used in aircraft production polymerize quite rapidly at about 170° F., it is unnecessary to raise the temperature of the wood parts to a higher level. As this temperature is below the level of the boiling point of water, there is no chance of scorching or blistering the wood as when hot plates are used. Furthermore, it is possible to maintain a uniform tempera

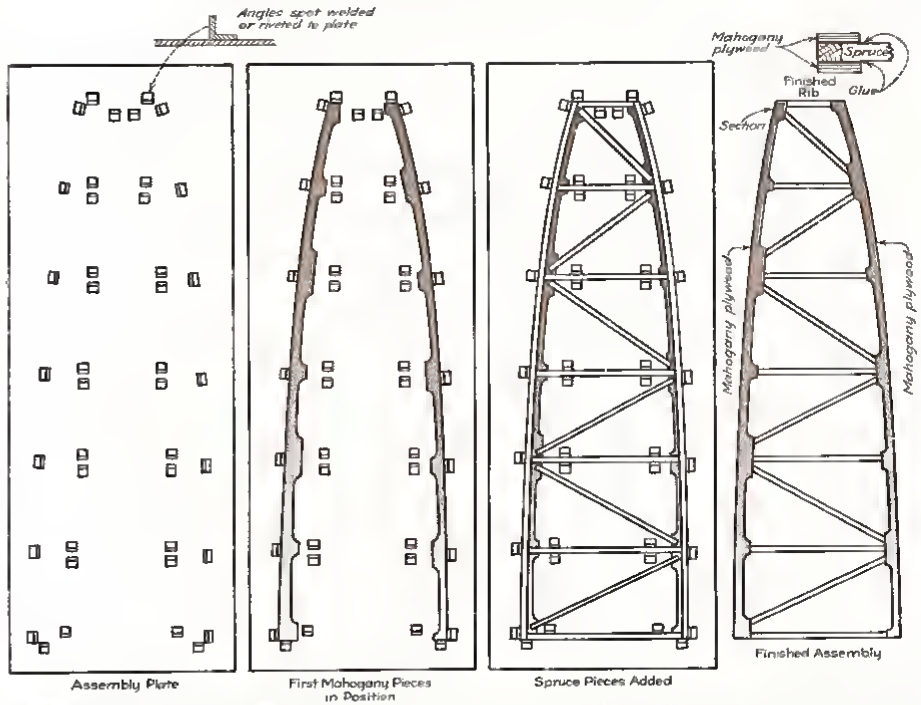


Fig. 10. Customary method of assembling aircraft wing ribs. Sheet aluminum assembly jig is provided with locating angle guides riveted or welded in exact position. First assembly step is to place glue covered mahogany strips in proper location. On top of these are placed spruce webbing strips in locating angle guides. Finally, two more mahogany strips are placed on top and assembly is covered with plate and placed in hot press for about two minutes. When sufficiently cool cover plate is removed and jig returned to line

Rib Ready to Go Into the Hot Press

Group of Assemblies Ready to Go Into Press

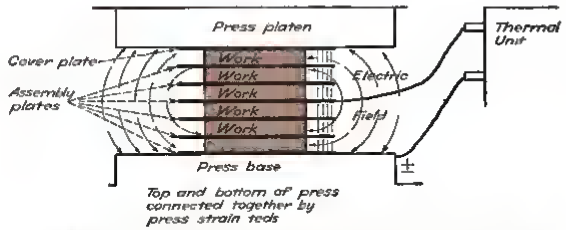
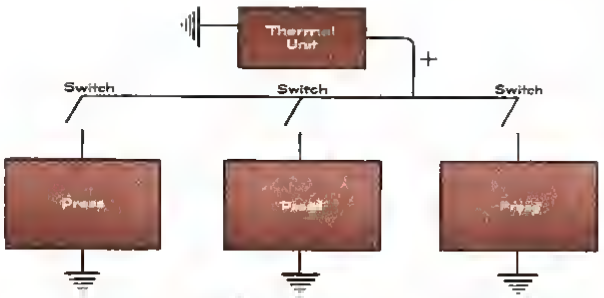


Fig. 11. In hot plate press only one assembly can be heated at a time. In press with high frequency heating, any number of plates up to foot or more depth can be treated simultaneously. Metal plates do not affect heating process. Electric field passes through wood as if no plates were present except that lines of force are made to pass through wood in parallel rather than curved paths.

ture through the whole stack of parts being glued. It is not necessary to maintain a high difference in temperature between the surface of the wood and its interior in order to drive heat through the wood to the glue. With high frequency every molecule is heated simultaneously and the whole is raised uniformly in temperature.

Take a stack of ¼-in three-ply sheets. Sixty-four of them could be put in a press and heated at one time. Each would receive exactly the same amount of heat. Fig. 5(A) shows diagrammatically a 12-in. stack of 64 three-ply sheets in a press. The other sketch shows how seven 1¾-in. finished planks can be glued together with equal ease in the same press. This indicates the wide range over which process can be used.



Where one THERMAL UNIT is used for two or more presses switches are interlocked so only one press can be connected at a time

Figs. 6 and 8 show how plywood is being bonded today in a large Pacific Coast plant. Figure 9 is a diagram showing how insertion of an electrode in the middle of the stack has eliminated the need of electrically insulating the press. Here the press is grounded and the high frequency electric field is set up between the central electrode and both the top and bottom platens of the press.

Typical Aircraft Applications

Applied to aircraft fabrication, there are so many possibilities here that space permits only a few to be mentioned. First, consider laminated wing spars. These are made by gluing wide planks together, the full length of the spar. Because of the thickness of the planks they have had to be held in clamps or presses for four or more hours. As long as the daily production was equal to the capacity of one press, this was no handicap—but as soon as war increased production, the need of more and more presses and the plant area to house them became a problem.

This problem could be solved in a hurry. The capacity of one press could be increased from 25 to 50 times by the addition of electrical field heating to speed up the setting of the glue.

Making ribs is a simple process, but the work takes a lot of space and presses if the ribs are left to dry at room temperature. At the present time, hot plate presses are used to speed up the glue setting. They are joined together with thin mahogany veneers so there is not much trouble in heating the glue. The average time in a hot plate press is about 1½ min. per rib. Use of the same press, but with application of high frequency heating, affords the possibility of producing a dozen ribs in the same time. These ribs can be stacked on their assembly plates, each plate acting as a cover for the one below. Aluminum plates are now used because of their high heat conductivity, but sheet iron or wooden plates would work equally well.

Introduction of metal plates between parts does not affect the heating, according to Thermex engineers. It only straightens out the electric field. This is shown diagrammatically in Fig. 11.

Gluing the skin on a wing is a job that must be done carefully. The whole assembly must be kept in a big rigid jig until the glue has set for at least four hours. It seems possible that this set-

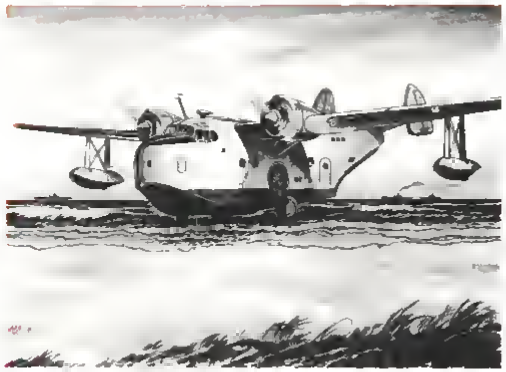
(*Turn to page 327*)

Fig. 12. Where loading and unloading takes about twenty minutes and volume of work warrants using three machines for continuous operation, one high frequency heating unit can be used. It should be connected so that only one press is in operation at a time. This shows how easily this process can be adapted to special needs.

B.F.GOODRICH RUBBER RESEARCH FOR THE

Aviation industry

B. F. GOODRICH BEACHING GEAR TIRES AND BRAKE TUBES OFFER MANY ADVANTAGES



Developments in beaching gear for seaplanes

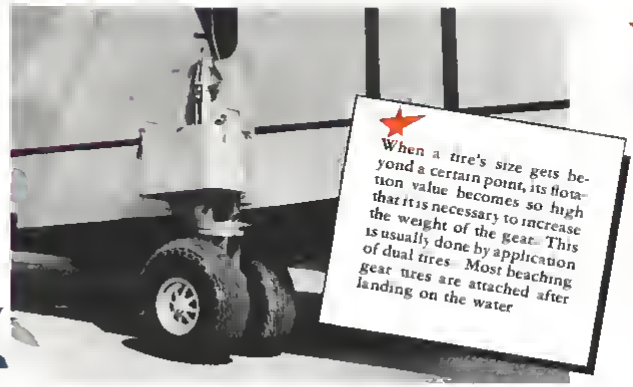
THE SPECIAL GEAR by which seaplanes are brought up on the land presented several distinctive engineering problems. The volume and weight of the beaching gear had to be carefully correlated so that the gear would float yet would not be too difficult to submerge. B. F. Goodrich engineers developed beaching gear tires that would meet this problem by carrying a load 50 per cent greater than the load carried by landing tires of the same size.

B. F. Goodrich makes available to the aviation industry both dual and single beaching gear tires. They are now in use on seaplanes made by all leading manufacturers.

The Expander Tube Brake also has distinct advantages when operating on beaching gear. This brake system contains no working metal parts to rust in salt water, since the synthetic rubber expander tube is cemented directly to the brake blocks. The expander tube operates by inflating and forcing the brake blocks against the brake drum with uniform pressure around the whole circumference. Applied to beaching gear, this principle provides perfect control of the plane, which is so important to the efficient handling of these giant ships. Unlike other systems, rust is not a problem with expander tube brakes for beaching gear.

Cementing brake tube directly to brake blocks eliminates need for metal parts which would corrode in salt water. The tube expands under a full circle of brake lining blocks and forces brake blocks against rim of wheel for smooth braking action.

This valve has been developed with a large orifice to permit filling the beaching tire with water when extra weight is required to immerse the tires. Its large-size opening makes it possible to fill the tire quickly and efficiently.



When a tire's size gets beyond a certain point, its flotation value becomes so high that it is necessary to increase the weight of the gear. This is usually done by application of dual tires. Most beaching gear tires are attached after landing on the water.

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FIRST IN RUBBER

Intercoolers and Their Performance In Aircraft

By **S. K. ANDERSON**, *Heat Transfer Engineer* and

P. A. SCHERER, *Research Engineer, AiResearch Manufacturing Company*

Intercoolers are likened to the old woman in a shoe — having so many parameters its hard to tell what to do. This fundamental article describes design limitations, defines basic parameters, establishes the current trend of intercooler design, and points the way to research to come.

IN THE RACE with our enemy for altitude, the manufacturer of supercharger intercoolers is faced with a multitude of problems. For the designer is only a pace ahead of production.

Intercoolers are a bit like the old woman who lived in a shoe. They have so many parameters it's hard to tell what to do. Engineers are confronted with not only the imposing list of heat-transfer symbols but those of aerodynamics, too.

Chief purpose of an intercooler is to increase the critical altitude of an military aircraft by cooling the supercharged engine air stream to the carburetor. The added equipment necessary to perform this task successfully burdens the airplane with a substantial weight and horsepower load, with a resultant sacrifice in range and valuable space. A high price!

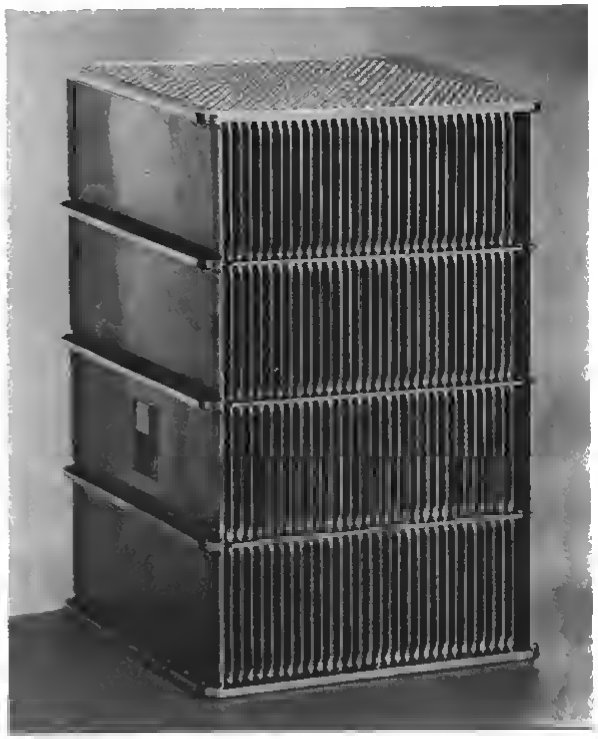
Yet the total values are worthy of these costs. We are purchasing altitude—including new lighting room, elected safety for ship and crew, attack power, specific performance of missions, and ability to get "upstairs" fast.

However, the price is so heavy that one of the *first* decisions in the design of a new ship must be its critical altitude the level at which it may still take out full engine power in climb and level flight.

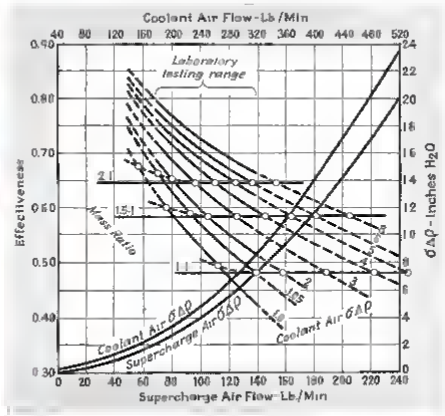
Performance of a heat exchanger may be presented in various ways, depending upon the function to be accomplished and the conditions of operation. In the case of intercoolers the manufacturer is asked to furnish a graph which will show the temperature and pressure drop in the supercharger air and the amount of coolant air which is required for a variation in any of the following items:

1. Supercharger air flow—W (lb per min.)
2. Supercharger air temperature to cooler—T_a (deg F)
3. Supercharger air discharge pressure—p_{ac} (in. Hg)
4. Coolant air pressure drop—Δp_c (in H_2O)
5. Coolant air temperature—t_a (deg F)
6. Coolant air pressure (altitude)—p_{ac} (in. Hg)

The graph which takes all these variables into account directly would, to say the least, be difficult to construct and cumbersome in use. It is therefore convenient to combine some of the variables and to show the performance for others reduced to a fixed standard from which the actual performance may be calculated.



Typical all-aluminum flat tube intercooler.

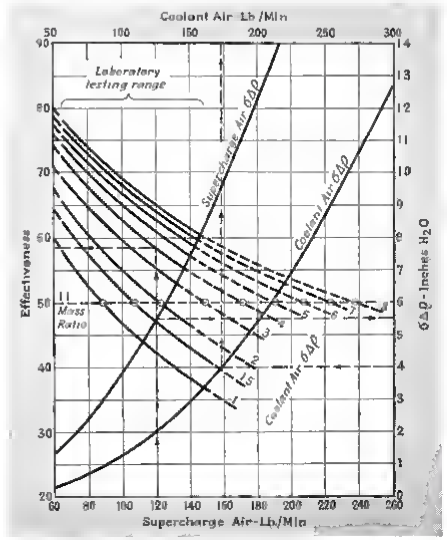


Such a "reduced" graph is shown in Fig. 1, in which the supercharger air flow has been chosen as abscissa. The ordinate represents effectiveness and is defined as the ratio of temperature drop of the engine air stream to the initial temperature difference between the two streams as they enter the intercooler

$$E = \frac{T_o - T_f}{T_o - t_o} \qquad (1)$$

Fig. 1. Typical intercooler performance curves.

E = effectiveness
T_o = Initial temperature of engine airstream (deg C)
T_f = Final temperature of engine air stream (deg)
t_o = Initial temperature of coolant stream, (deg)



Effectiveness combines items 2 and 5, in our list of variables, with the temperature drop in the supercharger air. The airplane designer knows the pres-

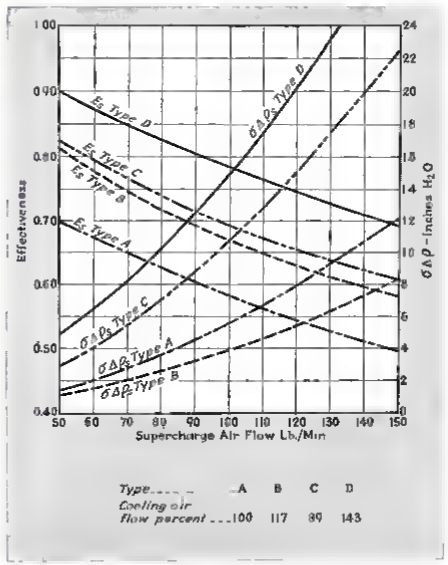


Fig. 2. Comparative performance of intercoolers of various types (see text).

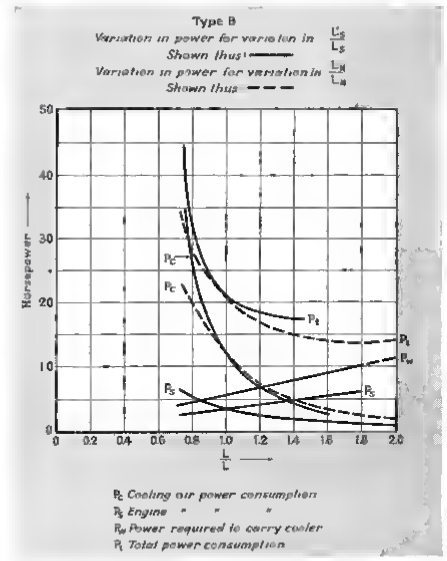


Fig. 3. Horsepower consumption versus ac-flow and engine air length for Type B intercooler (see text).

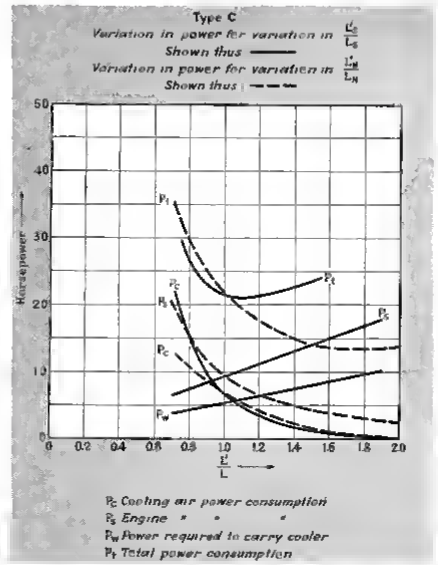


Fig. 4. Horsepower consumption verses air-flow and engine air length for Type C intercooler (see text).

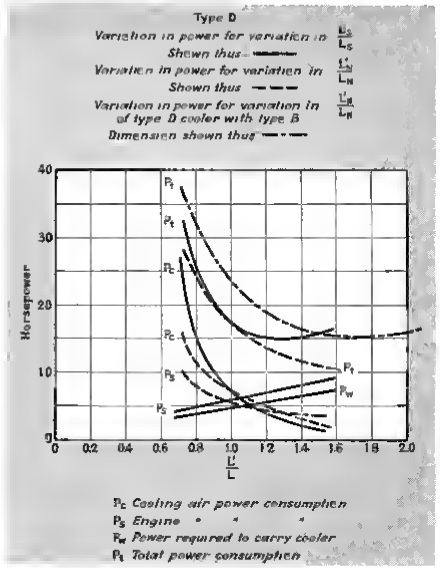


Fig. 5. Horsepower consumption verses air-flow and engine air length for Type D intercooler (see text).

sure drop that can be expected from the dynamic pressure of the airplane (q) in in. H_2O. The values of effectiveness (E) may be conveniently plotted for constant values of coolant air pressure drop reduced to standard air conditions ($\sigma\Delta p$) in "H_2O; a definite measure of coolant air mass flow in a particular core section.

The graph (Fig. 1) shows pressure drop curves for supercharger air flow and coolant air flow plotted for standard air ($\sigma\Delta p$) against weight flow as well as effectiveness values for a range of supercharger weight flows and coolant air pressure drops under standard air conditions. These pressure drops are from laboratory data corrected for the density existing in the center of the core, and therefore they automatically allow for variation in items 2, 3, 5, and 6, and the pressure drops themselves. The use of this chart resolves itself into determining the value of the ratio of the actual density of the problem to the density of standard air in the center of the core, whether it be engine or coolant air side.

Also, when the over-all heat transfer coefficients are known for a particular surface, the effectiveness E may be calculated from the following statement:

$$E = \frac{e^x - 1}{e^x - 1/R} \qquad (2)$$

where $X = NRa\left(\frac{R-1}{R}\right)$

and $Ra = \frac{SU}{60\ CpW_s}$

$e = 2.715$

N = Nusselt's factor for cross-flow

S = Primary heat transfer surface (sq. ft.)

U = Over-all heat transfer coefficient for primary surface $\left(\frac{\text{Btu}}{\text{sq ft, hr, deg F}}\right)$

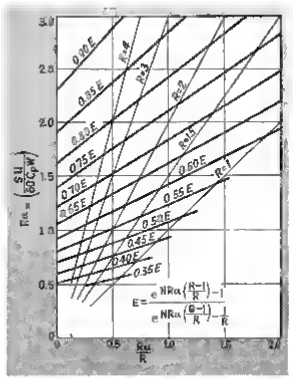


Fig. 6. Heat transfer rating sheet.

C_p = Specific heat of fluid at constant pressure (lb., deg. F. Btu) = 0.24 for air

W_s = Weight flow of supercharger fluid (lb. per min.)

W_c = Weight flow of coolant fluid (lb. per min.)

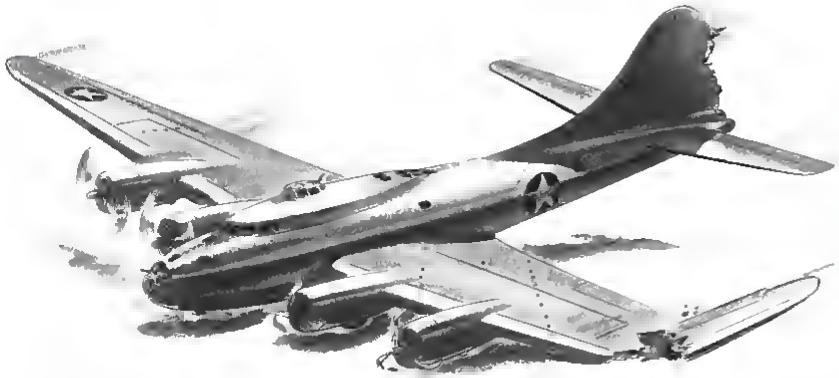
$R = \frac{W_c}{W_s}$

This gives definite values for all values of W and R, except when $R=1$.

The above equation is a simple derivation from the definition of effectiveness given above. It assumes that all the heat transfer flow is normal to the airstreams, that the specific heat at constant pressure is constant in the field as used, and that the logarithmic mean for counterflow, as modified by the Nusselt factor, is the true mean difference. It is a close approximation. This equation has been plotted (Fig. 6) and also serves to solve for the over-all heat transfer coefficient from the laboratory test data. Further uses of this chart will suggest themselves to the engineer.

Figs. 1 and 1a show a very useful relationship which can be investigated through a study of "Eq. (2)". In the field of turbulent flow for a mass ratio of 1 the effectiveness does not vary. For a higher mass ratio, the same fact is determined in a study of performance

(*Turn to page* 333)



DOWN BUT NOT OUT

Just because a fortress limps home from battle and pancakes to a crash landing with a shattered wing, crumpled props and daylight showing through her fuselage doesn't mean she is out of the fight. A ground crew of trained mechanics and technicians is on duty at every isolated airfield to see that battered ships are fit to fight again in short order. Their only "weapons" are precision tools like Dumore Tool Post Grinders . . . compact, versatile and dependable. In tiny maintenance huts beside jungle airfields . . . at base headquarters abroad and at home . . . in the teeming production centers of America's aviation industry . . . grinding to accuracies of one ten-thousandth of an inch is everyday performance with a Dumore. Flexible in application, Dumore Grinders may be mounted on a lathe, planer, shaper, miller or special machine tool to handle any grinding job . . . external, or internal to a depth of 24 inches . . . at speeds up to 42,500 r.p.m. Obtain complete details from Dumore Industrial Distributors, or write—

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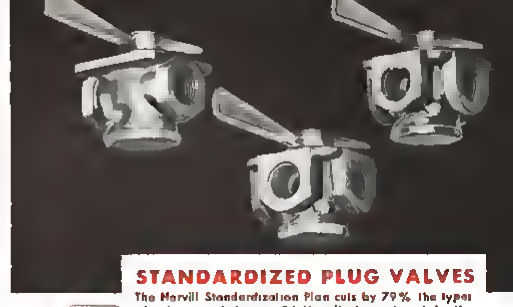

STANDARDIZED PLUG VALVES

The Harvill Standardization Plan cuts by 79% the types of valves needed—now 24 Harvill plug valves take the place of 1180 "non-standardized" valves. Two, three and four way—¼" to 1" sizes—produced by Pressure Mold Casting process which eliminates 83% of machining and 40% of metal requirements.

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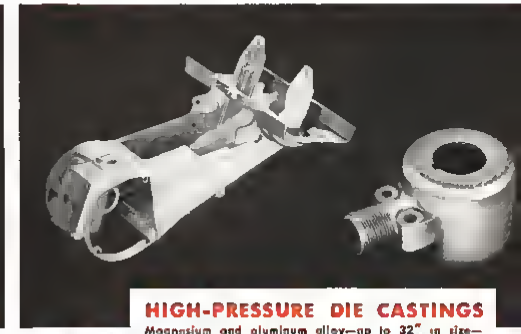
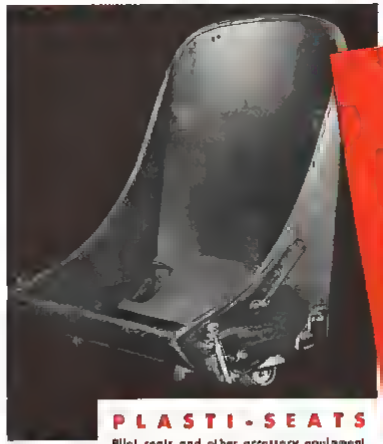
Many aluminum alloy structural parts formerly sand cast or forged are now produced at vastly higher rates and greatly reduced cost by Pressure Molding; covered by Army Air Forces specification 11257—tensiles up to 39,000 lbs. per sq. inch with 4.5% elongation in 2". Close dimensional control eliminates most machining, and reduces scrap to a minimum.



HIGH-PRESSURE DIE CASTINGS

Magnesium and aluminum alloy—up to 32" in size—controlled from alloying department to final inspection. Special machines and casting techniques assure close grain structure and uniformly high quality. Cast in bushings and other advanced methods save machine-shop time.



PLASTI-SEATS

Pilot seats and other accessory equipment produced from Harvill developed non strategic materials save metals and reduce weight. This plastic laminating process meets all requirements for lightweight, high strength and ease of production.

5 HARVILL-WAYS to speed production

The greatly expanded program of the Harvill Corporation—using many new production methods and materials pioneered by the firm during the past fourteen years—is speeding aircraft deliveries. Harvill hydraulic hand pumps and standardized plug valves break "delivery bottle-necks" and simplify installation . . . Harvill Pressure Mold and Die Castings eliminate from 60 to 90% of machining operations on structural and non-structural parts, besides conserving aluminum and magnesium . . . Harvill plastic pilot seats and other aircraft equipment provide new ways to save critical materials and weight.

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Besides new products and new materials, delivery schedules are hitting new "highs" in speed . . . production control and inspection methods developed by Harvill engineers insure the maintenance of highest quality. Write for descriptive literature on the products described above—and find out how Harvill products will help speed your production.

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Use of Glue in Aircraft Construction

By **J. T. STEPHAN**, *Chemical Engineer and Synthetic Resin Specialist, I. F. Laucks, Inc.*

Complete responsibility for successful application of plywood to aircraft construction rests with proper use of a bonding agent. This thoroughly documented and vitally important article is a major contribution to our mounting store of knowledge on plywood construction.

INCREASING USE of plywood and wood assemblies in aircraft places emphasis on wood as a material of construction as distinguished from aluminum alloys. Three factors which more or less govern the use of wood in aircraft are of small concern in fabricating aircraft of aluminum alloys.

First is the larger variation of the strength properties of the individual wood piece about the mean; second, variation in strength properties and dimension of wood with atmospheric changes; and third, variation in properties of wood with the three principal directions. Metals do not change shape by the absorption of water from the atmosphere, and their simple coefficients of expansion with temperature are well-known.

Wood, on the other hand, is an anisotropic material with a pronounced ability to swell. Unless sealed, treated, or impregnated, it will at all times tend to come to equilibrium with the moisture in the atmosphere. Such changes in moisture content are accompanied by changes in dimension, and these changes are different in the three directions in space. The result of these changes are evidenced in changed strength properties in the three principal directions and in what is commonly known as warping. In engineering design using wood as a basic material, these additional factors must be kept in mind if one is to produce balanced assemblies which do not warp or distort and which will have the desired strength for aircraft.

Wood alone is not satisfactory or self-sufficient to make aircraft. Wood must be joined to wood in such fashion that the stresses to which an airplane is subject in flight are carried well and distributed according to the plan of the aeronautical engineer. It is here that wood adhesives make possible the fabrication of wooden aircraft.

There are three government specifications which govern the quality of adhesives used in the aircraft industry. They are AN-NN-P511b (Army-Navy Aeronautical Specification Plywood; Aircraft, dated April 25, 1942), CG-456 (Federal Specification for Glue; Casein type, Water Resistant, dated July 8, 1942), and AN-G8 (Army-Navy Aeronautical Specification Glue; Cold Setting Resin, dated April 25, 1942).

Of these AN-NN-P511b specifies the required strength of plywood suitable for the manufacture of aircraft, and principally for plywood to be used in stressed skin construction of wing surfaces, gusset plates, etc. This specification requires the plywood to be bonded with a synthetic resin adhesive capable of retaining from 54.5 to 78.0 percent of the original specified dry strength of the plywood, depending on construction, after a 3 hr. immersion in boiling water.

This accelerated test distinguishes between plywood which can and cannot be expected to exhibit suitable strength properties after continuous severe weathering, such as the skin of a plane is subjected to in use. Adhesives of the quality necessary to make aircraft ply-

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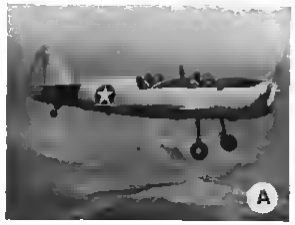


List of plywood airplanes in current operation is growing steadily and rapidly. Shown here are (a) Ryan PT-25, primary trainer; (b) Boeing AT-15, advanced trainer; (c) DeHavilland *Mosquito* reconnaissance bomber; (d) Beech AT-10, advanced trainer; (e) Curtiss C-76 *Caravan*, cargo carrier; (f) Fairchild AT-14, advanced trainer.

Variable gap glue spreader for spreading glue on scarfed joints in aircraft construction.

Forty-foot clamp for fabricating aircraft main spars. Two spars are locked up in this assembly.

An unusual method of cutting scarf joint in aircraft Sitka spruce with 14-in. milling disk. Disk has two sets of knives—one set on periphery for hogging other set on face giving wiping action to finish cut.

Assembly of spruce laminae for horizontal stabilizer into toggle press in which pressure is applied.

Cutting Zinc Alloy Dies For Salvage

In the "timeliest letter of the month", C. J. Frey of Brewster Aeronautical Corp. makes an important suggestion for conserving zinc in accordance with the Aircraft Production Board's directive. Mr. Frey has devised a hydraulic press cutting tool for cutting oversized zinc dies to size small enough for melting at the aircraft plant.

Brewster Aeronautical Corp

Mr. E Eugene Miller, Technical Editor
AVIATION, McGraw-Hill Publishing Co
330 West 42nd Street, New York

Dear Gene:

Conservation Directive No. 9, entitled "Zinc Forming and Stamping Dies", approved February 6, 1943 and released by the Aircraft Production Board Resources Control Office, requests that all users of zinc alloys, such as Kirksite, keep this material active. This alloy is extremely short and will continue to become more critical.

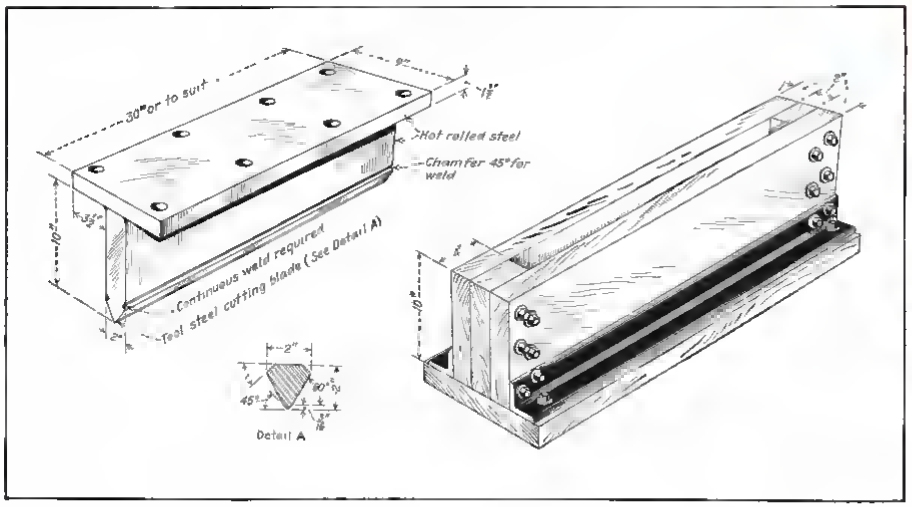
Any dies that are not active should be remelted to make new dies. Where the dies are too large for melting with the facilities at the aircraft plant, the manufacturers of the alloys have offered the use of their facilities to remelt them.

Since this would mean an added burden of many tons of car loading, to and from the alloy manufacturer, I am suggesting the use of a large blade to be used in a hydraulic press for cutting up the dies, which I have found to be very practical.

The blade as sketched is kept in a wooden container for storage and handling. The container may be placed on the bed of the hydraulic press and the upper ram lowered so that the blade may be fastened to it. The ram is then raised and a large zinc alloy die placed on the bed of the press with the aid of pipe rolls. Pieces of 2 by 4 wood blocks are placed under two opposite ends of the die and the blade forced down upon the center. The die usually cracks after the blade has entered only a small distance. The parts of the die may be shifted around and easily cut up in small pieces as desired. A protective layer of wood may be placed on the bed of the hydraulic press so the bed will not be damaged.

Since practically all aircraft manufacturers have a hydraulic press, the breaking up of dies can be easily accomplished in their own plants. The large dies may be accumulated, the press set up and the dies quickly reduced to a convenient size without delaying production to any great extent.

Sincerely yours,
(sgnd) C. J. Frey
Chief Tool Designer



How to Fair Lines By Graphical Calculus

Part II

By **DEAN MADSEN**, *Lofting Engineer, Northrop Aircraft, Inc.*

Applying salient mathematical principles which have effected new accuracy and economy in lofting, the author has developed his Madsen Method. Here, presentation of this advanced system is concluded with an analysis of non-integer station procedure.

SIGNIFICANT PROGRESS has been achieved in lofting technique during the last few years, most notably through methods based on mathematical principles—methods which have proved of decided value to the aircraft industry because they have provided greater accuracy while effecting savings in time, floor space, and labor costs.

However, further simplification still seemed indicated. And to this end we have aimed to replace former lengthy calculations and complicated formulas with a simple graphical method of obtaining a perfectly fluid and defined double-curved surface, any part of which is available to an accuracy of 0.001 in.

Accordingly, this study sets forth a method which not only combines what we believe to be the best of the developments of recent years but which in addition introduces a new idea—the adaptation of calculus to the problem of fairing. Having detailed in Part I (page 136, Jan. AVIATION) the fairing of one line, with determination of offsets for certain integer stations, we now conclude with an analysis of the method of determining offsets for non-integer stations, since many structure stations will be on non-integer dimensions.

Two types of non-integer base axis stations are encountered. First, those represented by graph lines of the graph paper; second, those not thus represented. Offsets for those non-integer stations that *are* represented by the graph paper lines can easily be obtained by employing the same method as that used for determining the integer station offsets. And offsets for those non-integer stations that *are not* so represented pose a problem of interpolation. Fig. 9 illustrates this problem. Station *R* is the non-integer station for which the offset is to be determined.

Basic principle employed is to determine a trapezoidal area, contained under the first derivative curve and between the station of unknown ordinate and a station of known ordinate, and adding the area, algebraically, to the known ordinate to obtain the value of the unknown ordinate.

First, determine graph-line represented stations (*P* and *Q*) on both sides of the non-integer station, such that a straight line assumed for the first derivative curve, between stations *P* and *Q*,

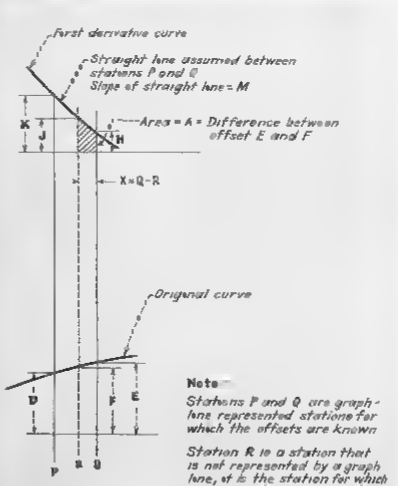


Fig 9

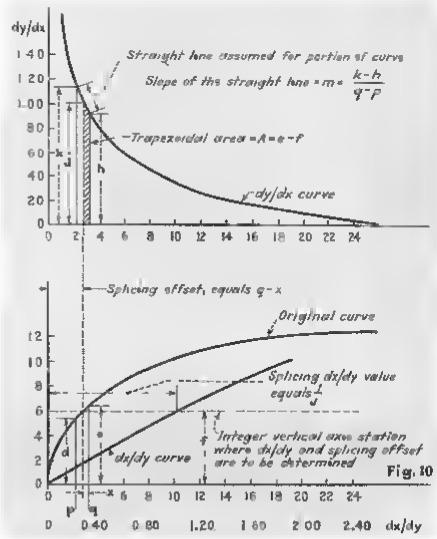


Fig. 10

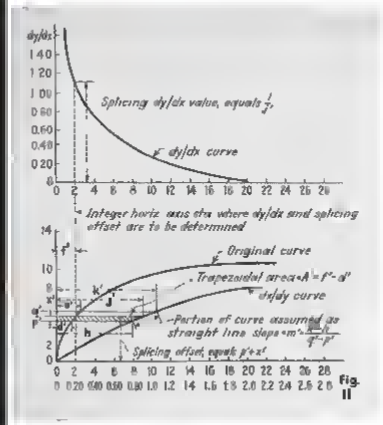


Fig. 11

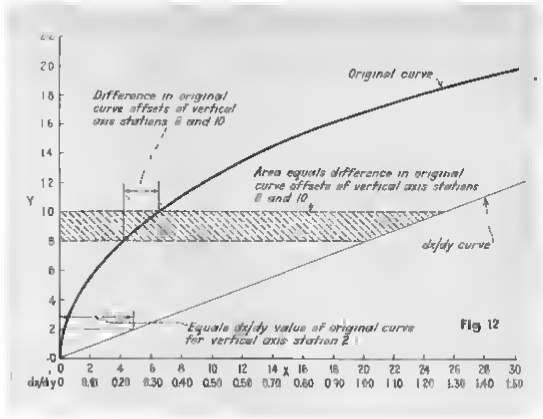


Fig 12

will subtend negligible A and B areas of Fig 7 (page 140, Jan. AVIATION). Assume the straight line. Now, after studying the sketch, observe the following:

$$X = Q - R$$

$$M^* = \frac{K - H}{Q - F}$$

and

$$J = H + M X$$

$$A = H X + \frac{M X^2}{2}$$

Desired offset for the non-integer station R is F

$$F = E - A$$

Slope of the non-integer station R is equal to J

$$J = H + M X$$

The above procedure should be considered as typical, with alteration of the equations to fit the particular problem. Area A should always be taken between the non-integer station for which the offset is to be determined and the closest station of known offset. (There are other methods which can be used to obtain the non-integer station offsets which are sometimes shorter, but the method explained above is basically correct and will apply in every case.) Thus we have faired out line and obtained offsets for any station.

It has, however, been pointed out that large or extreme values of dy/dx are sometimes encountered, and this requires a slightly different technique—

Handling Extreme Values of dy/dx

When the slope values of the original curve, as read to the horizontal axis, become so large that they are impractical to plot, the slopes are read and plotted, in a similar manner, against the vertical axis. The resulting curve is called the dx/dy curve.

In effect, this dx/dy curve is similar to the dy/dx curve, except that in the former all considerations are made to a vertical axis base, while for the latter all considerations are made to a horizontal axis base. Fig. 10 shows a typical dx/dy curve. Note that for a particular point on the original curve, the dx/dy value is the reciprocal of the dy/dx value.

It is necessary to lap, or splice, the two derivative curves, (i.e., maintain exactly equivalent values of dy/dx and dx/dy for the splice area) in order that the slope values, and hence the offsets of the original curve, will be smooth and fair when passing from the area governed by one derivative curve (dy/dx) to that area governed by the other derivative curve (dx/dy).

Usual practice is to determine one derivative curve and then determine the other after properly splicing to the former. We shall consider the dy/dx curve as the first determined and that the dx/dy curve is to be determined. The reverse condition would be similar.

Splicing dx/dy Curve to dy/dx Curve

Two distinct problems are met when splicing the dx/dy curve to the dy/dx curve. First, values of dx/dy must be determined from dy/dx in the splicing area. Second, an offset determined from dy/dx must be used as a starting point for the subsequent offsets to be determined from dx/dy.

The dx/dy values are plotted against integer base axis stations. Therefore, the splicing slope values and the splicing offset value for the dx/dy curve will be obtained on integer stations for the dx/dy curve.

Determining Values of dx/dy From dy/dx

Refer to Fig. 10 for illustration of the following section, and note that when the slope of the original curve is equal to 45 deg., $dx/dy = dy/dx = 1$. The splicing area is, therefore, in the vicinity of where $dy/dx = 0.80$ to $dy/dx = 1.20$.

Choose an integer vertical axis station as a splicing station, for example, dimension f. Determine the section of dy/dx that spans station f and assume a straight line for that portion of dy/dx. Stations p and q should be determined such that the assumed straight line will subtend negligible areas of A and B shown in Fig. 7 (page 140, Jan. AVIATION.)

Again refer to Fig. 10 and observe the following:

dx/dy of Sta. $f = 1/j$

Area $A = e - f$

Slope of assumed straight line =

$$m = \frac{k - h}{q - p}$$

Splicing offset tying dx/dy to dy/dx =

$$q - x$$

$$j = mx + h$$

The area designated as A can be expressed

$$A = hx + \frac{mx^2}{2}$$

or

$$mx^2 + 2hx - 2A = 0$$

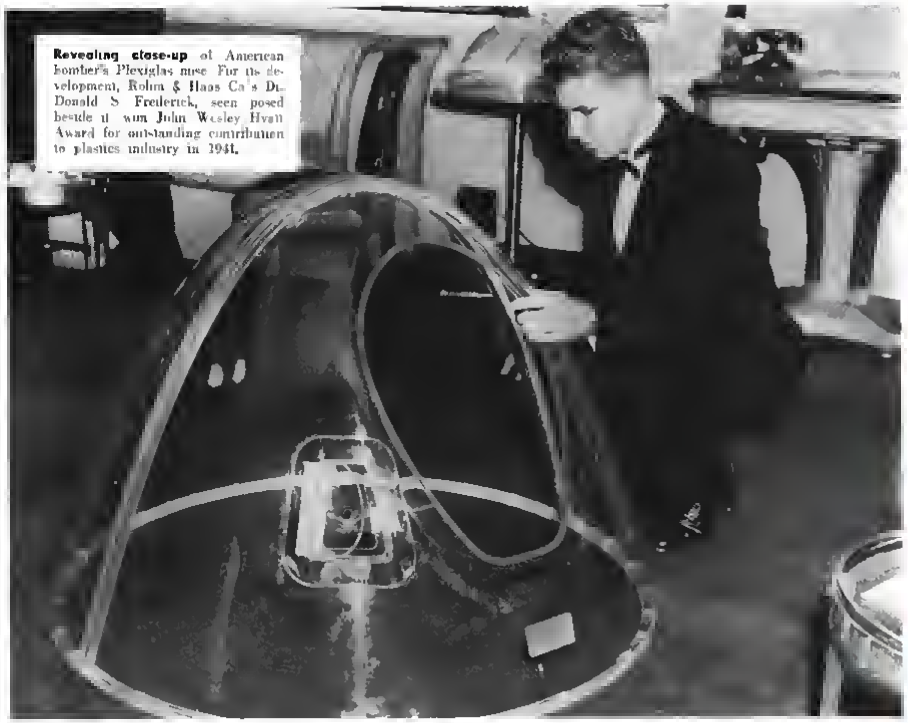
solving for x

$$x = \frac{-2h \pm \sqrt{4h^2 + 8Am}}{2m}$$

$$x = \frac{-h \pm \sqrt{h^2 + 2Am}}{m}$$

(Turn to page 338)

* Observe from the sketch that a strict interpretation of the direction of the assumed straight line gives the slope M a negative value. However, for the non-directional geometric solution for which it is utilized a positive value should always be used for M.



Revealing close-up of American bomber's Plexiglas nose. For its development, Rohm & Haas Co.'s Dr. Donald S. Frederick, seen posed beside it, won John Wesley Hyatt Award for outstanding contribution to plastics industry in 1941.

Strength Properties Of Plexiglas

Part II

By **W. F. BARTOE**, *Chief Physicist, Rohm & Haas Company*

Searching tests of Plexiglas provide a guide to its most effective applications. Author Bartoe detailed the basic and impact-strength factors of this transparent plastic in January AVIATION. He now concludes with a salient study of its tensile and flexural strength.

PRIMARY IN DESIGNING Plexiglas applications for aircraft structures are considerations of three factors—its impact, its tensile, and its flexural strength. Having already dealt with impact-strength tests and results (Part I, page 128, January AVIATION) let us now give our attention to the latter two factors, first considering—

Tensile Strength

As determined by ASTM method D 638-41T, using a Navy Aeronautical Specification P-41b specimen, Plexiglas has a maximum tensile strength of 7,000 to 8,500 psi at 25 deg C (77 deg F).

In calculating the tensile strength, a specimen of the shape shown here in Fig. 1 was used. Preparatory to such testing, the piece is machined to the rough required shape, then the edges are filed and sanded to produce a smooth, but not polished, surface. Width and thickness are measured to the nearest 0.001 in. and to the average values used in computation. Two ink dots are placed 2 in. apart on the narrow section of the specimen, and the separation of these dots during the test (also measured to 0.001 in.) is

taken as the elongation, or strain, of the sample.

This stretching naturally affects the dimensions of the specimen, but for purposes of simplification, stress values are calculated on the basis of the initial section area.

Surfaces at both ends of the specimen are roughened with a rasp, and strips of emery cloth are placed around them to prevent slipping. They are then inserted in the jaws of the testing machine. These grips are self-aligning so that there will be little or no shearing, flexing, or twisting of the specimen during the test.

Jaws are mounted to the cross-heads of a universal testing machine capable of loads ranging from 1,000 to 10,000 lb. The machine is adjusted so that the cross-heads separate at a specified rate (usually .05 in. per minute). In actual testing work, this rate may vary slightly, but it is essentially constant. The load applied to the specimen—which depends on the resistance to elongation offered by the sample—is measured by a balance mechanism and recorded at regular intervals.

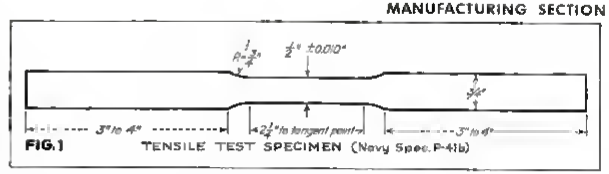


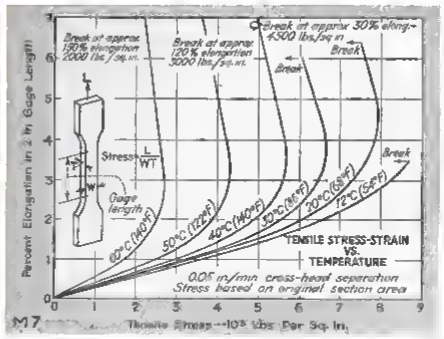
FIG. 1 TENSILE TEST SPECIMEN (Navy Spec. P-41b)

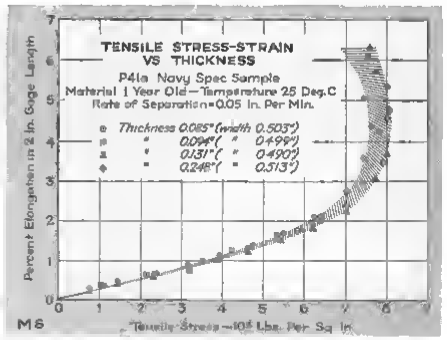
KEY TO GRAPHS AND TABLES

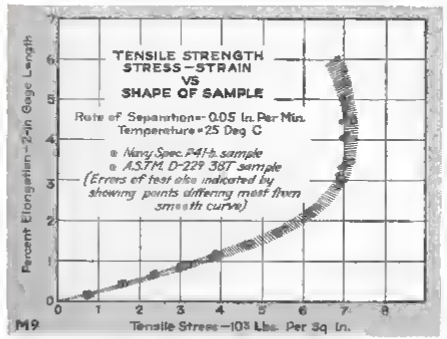
(For Graphs M1 through M6 and Tables I through III, see Part I of this article, page 138 Jan. AVIATION)

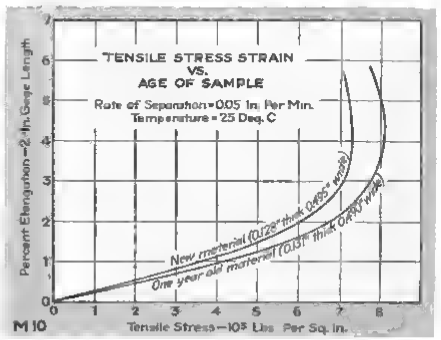
Factor	Impact Strength	Tensile Strength	Flexural Strength
1 Temperature	Graph M1 Graph M2	Graph M7	Graph M14
2 Thickness	Graph M3	Graph M8	
3 Size & shape	Graph M4–5	Graph M9	
4 Age & preconditioning		Graph M10–11	Graph M15
5 Rate of straining	Table I	Graph M12	Graph M16
6 Other factors			
shape of notch	Table II		
surface condition	Table III		Table III
depth of scratch	Graph M6		Graph M6
pre-stretching		Table IV	
orientation on sheet		Graph M13	

First portion of a room temperature stress-strain curve follows a straight line. Between 6,000 and 7,000 psi, the sample begins to stretch a little more easily and the curve turns upward, reaching a maximum stress of 7,500









psi and an elongation of about 4 per cent. Then, as the sample starts to elongate even more easily (offering less resistance to stretching) the stress drops off. The final breaking point (ultimate tensile strength) may be as low as 5,500 psi or as high as 7,000 psi., depending on final elongation which may range from 5 to 15 percent.

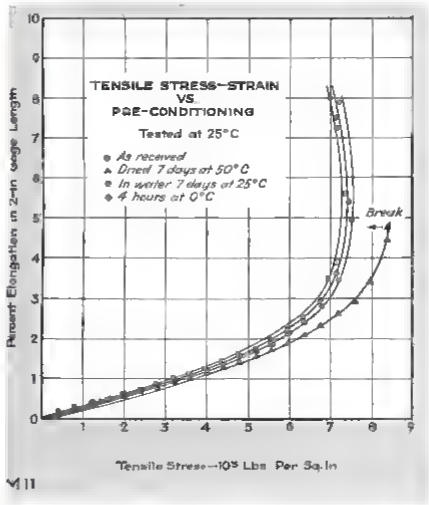
This spread in ultimate values is apparently due to minor factors, such as humidity, surface of the sample, methods of cutting, and other minor mechanical variables. Therefore, maximum tensile strength, which is reproducible, is usually given in tables of data, not only because of this wide variation in ultimate values but also because the maximum is of more practical value in design work. Data

Temperature. Data in Graph M7 show effect of temperature on the tensile stress-strain properties of the material. At 60 deg. C (140 deg. F.) the stress or resistance to stretching never exceeds 3,000 psi., and the break occurs at about 150 percent elongation. At 12 deg. C (54 deg. F.) the material is more rigid but capable of carrying a tensile stress more than three times as great.

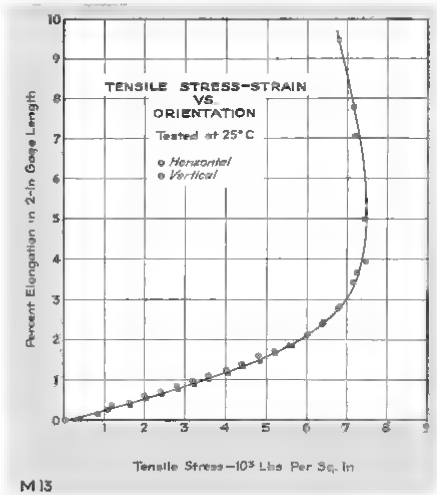
Thickness. In tests conducted with four different thicknesses, the data shown in Graph M8 were obtained. The experimental points fall so closely together that a shaded area is used to indicate the range of the data. Values for maximum tensile strength do not vary by more than 600 psi., which is probably not more than twice the experimental error of the tensile test.

Shape. The Navy Aeronautical Specifications P-41b, issued in 1939, called for tensile tests with a specimen differing slightly from that specified by ASTM D-229 38T.* Specimens and offered an opportunity for the comparison shown in Graph M9. Essential difference between the two specimens is in the radius of the shoulder of the neck. P-41b calls for 750 in., while D-229 38T calls for 3.0 in. This graph, incidentally, is drawn from data on ten tests with each specimen. For simplification, only the most divergent points are shown in order to indicate the errors inherent in the test method. As

* Most recent Navy Specification (P-41c) calls for same specimen as D-229 38T and D-638 41T.



M 11



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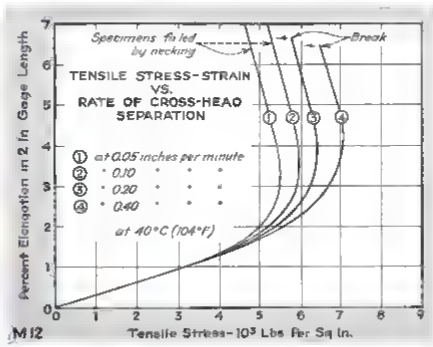

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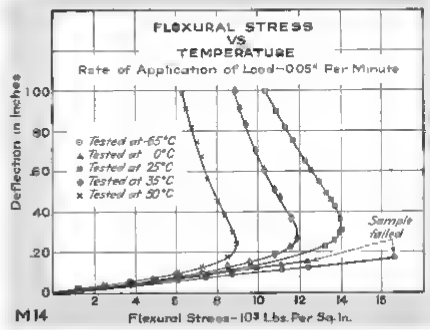


M 14

may be seen, this range is roughly 400 psi.

Age and Pre-Conditioning: Graph M10 shows a comparison of new Plexiglas with material which had been stored for one year. The greater maximum tensile strength of the latter may be due to a lower water content (see Graph M11), to the effect of some very slight additional polymerization, or to the expected variations between batches of material. In any event, it is obvious that the year's aging caused no significant deterioration or embrittlement of this transparent plastic.

Experiments to determine the water absorption characteristics show that, when immersed in water, the material takes up moisture quite rapidly for the first seven days, then slowly approaches an equilibrium after approximately 40 days. Dehydration data follow a similar curve in that 75 percent of the total water loss occurs in the first week of heating in a drying oven. Therefore, seven days immersion at 25 deg. C. ± 1 deg. C. and seven days drying at 50 deg. C. ± 1 deg. C. were selected as logical extremes to determine the effect pre-conditioning has on tensile strength.

In addition, data are included on the effect of four hours at 2 deg. C., since this pre-conditioning is required by Navy Aeronautical Specification P 41c. Regardless of pre-conditioning, all specimens were pulled at 25 deg. C. All of the data is included in Graph M11, together with that for a specimen of Plexiglas as received from the plant, i.e., with no especial pre-conditioning.

As the graph indicates, the dehydrated samples show a higher maximum tensile strength, higher ultimate or breaking strength but much less elongation than the immersed samples. Probable explanation is that the moisture mechanically "lubricates" the material, making it more extensible. Even so, the difference between maximum tensile strength for the various pre-condition-

TABLE IV

Stretching	Average Maximum Tensile Strength (psi)	Average Ultimate Extension (percent)	Average Ultimate Tensile (psi)
None	7 530	20	6 730
Longitudinal 10 percent	7 630	40	6 080
25 "	7 780	35	6 130
50 "	7 750	60	6 600
75 "	8 000	50	7 710
100 "	8 080	60	8 080
Transverse 10 "	8 120	1 3	7 090
25 "	7 970	1 3	7 970

ing is small—only about three times the normal experimental error.

Rate of Straining: Data in Graph M12 show that different rates of straining—or more exactly, different rates of cross-head separation—may cause as much as 1,700 psi difference in maximum tensile strength and a corresponding variation in elongation. This effect, shown here for 40 deg. C. (140 deg. F.) is also true at room temperature. In general, however, results obtained at the slower speeds are more reproduceable and hence most widely used in the plastics industry. Other factors—

Pre-Stretching: As mentioned in the introductory remarks, (see Part I, January AVIATION) various spot tests have suggested that stretching sets up a "grain" in the Plexiglas in the direction of the stretch. A logical explanation of this effect is that the polymer chains formed during the casting of the plastic may fall into parallel alignment during the stretching operation.

To obtain a quantitative expression of this effect, 1½ in. x 12 in. strips were stretched 10, 25, 50, 75, and 100 percent of their original length, and tensile specimens were cut with their long axes parallel to the direction of stretch. Similarly, 8 in. x 10 in. plates were stretched to 10 and 25 percent of their original length, and tensile specimens were cut with their long axes perpendicular to the direction of stretch. Mechanical difficulties of stretching an 8 in. x 10 in. sheet uniformly more than 25 percent of its length prevented our extending this data further.

Data obtained by pulling tensile tests on these specimens are summarized in Table IV. As may be seen, the pre-stretched tensile samples show higher maximum tensile strength.

These facts, while indicating a trend are probably not so significant in themselves as a comparison of the ultimate strengths and elongations of the various samples. For samples longitudinally pre-stretched only 10 or 25 percent, these values are as variable as for unstretched samples. But as the pre-stretching increases, they become more consistent.

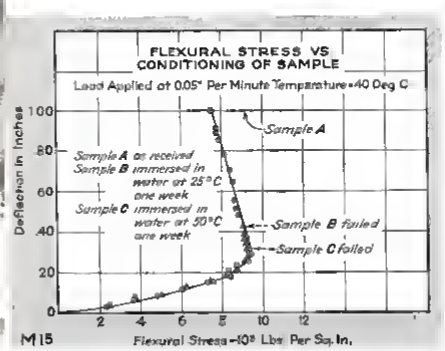
Both sets of transversely pre-stretched samples also show this tendency. In addition, their ultimate strengths are very close to, or identical with, their maximum strengths. This, too, would confirm the grain theory.

However, there is no grain in flat unstretched sheets. The two curves shown in Graph M13 represent tensile tests run on samples cut from the same sheet of Plexiglas but with their long axes at right angles to each other. There is no appreciable difference between the two curves.

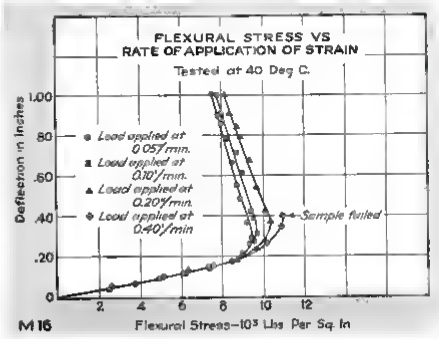
Flexural Strength

According to ASTM method D-650 41T the maximum flexural strength of Plexiglas is approximately 14,400 psi. at 25 deg. C. (77 deg. F.).

(*Turn to page* 359)



M 15



M 16

Theory and Technique Of Perspective Projection*

Part II. By GEORGE F. BUSH, *Assistant Professor of Graphics, Princeton University*

Increasingly favored on aircraft production lines, perspective engineering illustrations are both supplementing and replacing ordinary blueprints—thus creating a wide demand for personnel trained to make these drawings. Second of a series on graphical projection fundamentals, this article details two-point perspective principles

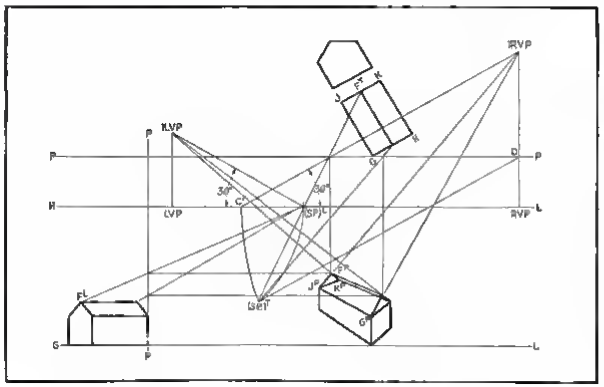


Fig. 8. Two-point perspective by Methods 1 and 2, including inclined *VP* (front edge in *PP*)

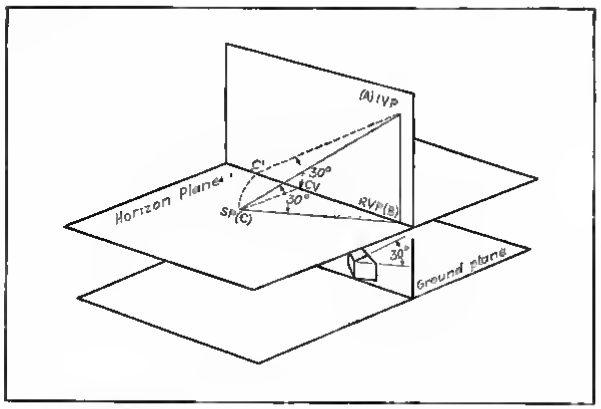


Fig. 9. Pictorial view of construction for determination of *IVP*

WHERE SHAPE-DESCRIPTION is concerned, pictorial drawings and sketches, employing isometric, oblique, and perspective projections, are generally decidedly superior to the conventional engineering drawings using orthographic projection. Through these pictorial presentations, the essential shape and basic component parts of an object are revealed at a glance. Little or no training is required to read these revealing drawings. Hence, the growing importance of perspective projection.

Having detailed the introductory principles and one point projection in Part I of this series (page 118, Jan. AVIATION) we will now consider two-point projection, including inclined vanishing points and reductions and enlargements.

Method 1 Simpler

To begin with, if the box of our Fig. 5 (page 125, Jan. AVIATION) is now turned so that its front makes an angle of, say, 30 deg. with *PP*, as shown in the top view of Fig. 8, then the two-point perspective shown in this Fig. 8 is obtained. (In this two point perspective, the front, vertical edge of the box may also be behind *PP*.) As in one-point perspective, the construction of the perspective view by Method 1 is much simpler than that by Method 2 (see Methods below Fig. 5). Typical of this simpler construction is the drawing of the two lines $F^2(SP)^2$ and $F^1(SP)^1$, as shown, to find where these sight lines pierce *PP*, so that the intersection of the horizontal and vertical projection lines from these latter points may be found. This gives F^p in the peak of the roof. Compare this simple procedure with that of Method 2, description of which follows.

* A book, *Engineering Sketching*, is being prepared by Mr. Bush for early publication.

To find F^p by Method 2, first apply Principle 1—i.e., that the perspective projection of a point is the intersection of the perspective projections of two lines through that point. Assuming that the two lines selected, according to this principle, are the inclined ones passing through *F*, we now apply Principle 2 (i.e., that each set of parallel lines in space has its own *VP*, which is located from points where sight lines, parallel to the set, pierce *PP*) to find the *VP* for each set of parallel lines involved. And by selecting these lines, we learn at the same time how to find an *inclined VP*. One set will be parallel to one of the inclined lines, the other set will be parallel to the other inclined line.

The *VP* for each set is located from a point where a sight line parallel to the set pierces *PP*. Hence, the inclined sight *VP (IRVP)* will be on the line *L* of Fig. 9.

This latter figure also shows that the *IVP* is always above *VP* (in *HL*); more specifically, that the *IRVP* is always directly above *RVP*. Assuming that the pitch angle of the roof is known as 30 deg., we find that, to lay out this angle in its true size, the triangle *ABC*, containing the 30 deg. angle, must be revolved about the line *AB* until it lies in *PP*, as shown in Fig. 9. This construction for finding the *IVP* can now be more clearly followed in Fig. 8. *BC* of Fig. 9 is $(SP)^1(RVP) = C'(RVP)$ of Fig. 8, etc. In Fig. 8, *C'*, in *HL*, can therefore be found by swinging an arc, with center at *RVP* and radius equal to $(SP)^1(RVP)$, from $(SP)^1$. From *C'* at 30 deg. line is drawn until it intersects the vertical through *R*1 *P*.

To Locate RVP

Answer to the question, "How is *R*1 *P* located?" is found by applying no Principle 2. The set of horizontal lines converging at *RVP* in *H* is not parallel or perpendicular to *PP*. Hence, as Table 1 (page 349, Jan. AVIATION) indicates, their *VP* is in *HL*, but not in *L*. From Principle 2, the *VP* for this horizontal line-set is located from the point where sight lines, parallel to this particular line-set, pierce *PP*. In Fig. 8, the line $(SP)^1D$, parallel to *GH*, pierces *PP* at *D*. *R*1 *P* is the only point which can be at *D*, in *PP*, and in *HL*.

This construction for finding *R*1 *P* is typical of the general procedure used for finding any *VP* in *HL*.

With the above question now answered, the explanation of the construction for finding, in general, any *I*1*P* is now complete. The 30 deg. triangle of Fig. 8 can now be constructed and the *IR*1 *P* found thereby. Having found *IRVP*, the perspective of one of the inclined lines through *F* can now be drawn.

In a manner similar to the above procedure, *ILVP* can be found and the perspective of the other inclined line through *F* can be drawn. Recalling Principle 1, the intersection of these two inclined-line perspectives is F^p of Fig. 8. Points J^p and K^p, from which these inclined lines are drawn, are found by methods and constructions heretofore described.

Before leaving Fig. 8, it is well to note that the *VP* of two parallel inclined lines, not perpendicular and not parallel to *PP*, is not an infinite distance away, as might also be inferred from Table 1, where it is indicated that if these inclined, non-horizontal lines *are* parallel to *PP*, then the perspective projections of these lines will be parallel to them in space. The lines of Fig. 8 are *not* parallel to *PP*, so the *VP* is a finite distance away. Hence the perspective projections of the inclined lines will *not* be parallel, as inspection of Fig. 8 confirms.

The parallelism of inclined lines in space, which are parallel to *PP*, and their perspectives can also be reduced geometrically. Fig. 10 shows the top and end view of a triangle *ACD* in (a). *ACD* is parallel to *PP*, as indicated. The two triangles formed by sight lines to the points *c*, *C'* and *D* in the top and end views are shown at (b) in reference to a line representing the edge views of the triangle. Here, *y* is the horizontal distance from SP to *PP*, and is measured perpendicular to *PP*. And *x* is the perpendicular distance from SP to the triangle. From the triangles at (b) . . .

$$\frac{(SP)^R G}{(SP)^R A^R} = \frac{a}{b} \text{ and } \frac{(SP)^T K}{(SP)^T A^T} = \frac{c}{d} \quad (1)$$

$$\text{and } \frac{(SP)^R G}{(SP)^R A^R} = \frac{(SP)^T K}{(SP)^T A^T} \quad (2)$$

$$\text{Therefore } \frac{a}{b} = \frac{c}{d} = r \quad (3)$$

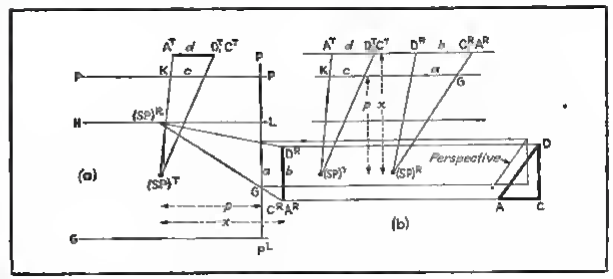


Fig. 10. Graphical basis for determination of perspective of inclined lines, also reduction and enlargements, per one point perspective.

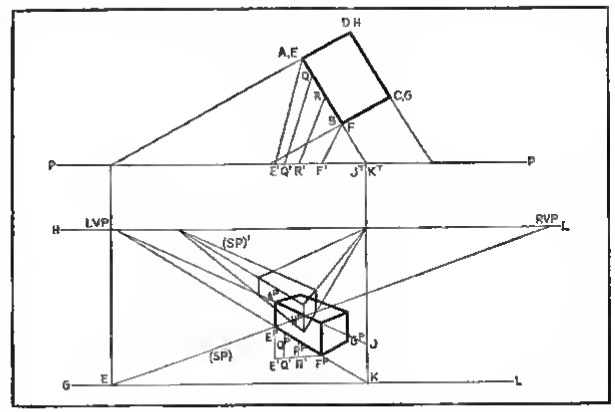


Fig. 11. This two-point perspective (front edge not in *PP*) is also an expedient.

The smaller triangle with legs a and b, is shown also at (b). And as (3) indicates, these legs are in proportion to those of the larger triangle. Since it is known that vertical lines will have vertical perspectives, and horizontal lines horizontal perspectives, the smaller triangle will also be a right triangle. Hence the two triangles at (b) are similar, and the inclined line $4D_v$ parallel to PP_1 will always be parallel to its perspective at *one point* perspective.

If the ratio r is, say, $\frac{1}{2}$, then by geometry $p = x/2$. And r is therefore a ratio for reduction or enlargement of perspectives. For example, if an auxiliary PP is so placed that $p/x = \frac{1}{2}$, then the perspective is a half (linear) *reduction* of the object size; if $p/x = 2$ then the perspective is a double (linear) *enlargement* of the object size.

Re "Measuring Points"

The above geometrical treatment is typical of the mathematical approach which can be used in conjunction with a graphical one in the deduction of many important rules, constructions and the like, in the broad subject of perspective. One particular construction involves "measuring points", of which C' in Fig. 8 is one. Long and varied tables data for which can be determined by mathematical or graphical methods based on these measuring points, are often compiled to facilitate the shortest construction. When Method 2 is used, the use of similar tables is a questionable point.

When the front edge of the object is behind the PP_1 as in Fig. 11, the perspective can again easily be obtained by Method 1. That an explanation of the construction in this instance by Method 1 is exact repetition of that for Fig. 8 attests the inherent simplicity of the method. By Method 2, one would proceed to find, for example, point E', the perspective of the back bottom left corner of the box, as follows: To apply Principle 1 first find the perspectives of the two lines say EI and EH, through E. The perspective projection of II is found by extending IE to the top run to K' in PP. Since this line is in GI, K is in GI. The perspective of EI is therefore drawn from A to $I'P$ as shown.

Similarly the perspective of line EH is drawn from E to $H'P$. (As to Fig. 8, the VP is found by application of Principle 3, i.e., draw lines from SP to PP then project down from these PP piercing points to HL to get VP for a set of horizontal lines not parallel or perpendicular to PP.) The intersection of the two perspective lines will now give E'. It should be noted that elevation which can be supplied by an end view of the box, as necessary requirements. For example, to draw the perspective from J in order to obtain, say, point A' the height of the box, JA, must be known.

The remaining constructions in Fig. 11 will be explained in later, appropriate portions of this series of articles.

Two engineering perspectives, employing two-point perspective, are shown in Fig. 12 and Fig. 13. Fig. 12 is an "exploded" assembly presentation of a flexible fuel tank which mechanism, and is one of thousands of such perspectives used in North American Aviation to expedite production of their aircraft. And Fig. 13 is a perspective, partly sectional, used to show the final assembly of the tail control mechanism of the Lockheed Aircraft Corp.'s *Lodestar*. Note how the shading of this drawing heightens the pictorial effect.

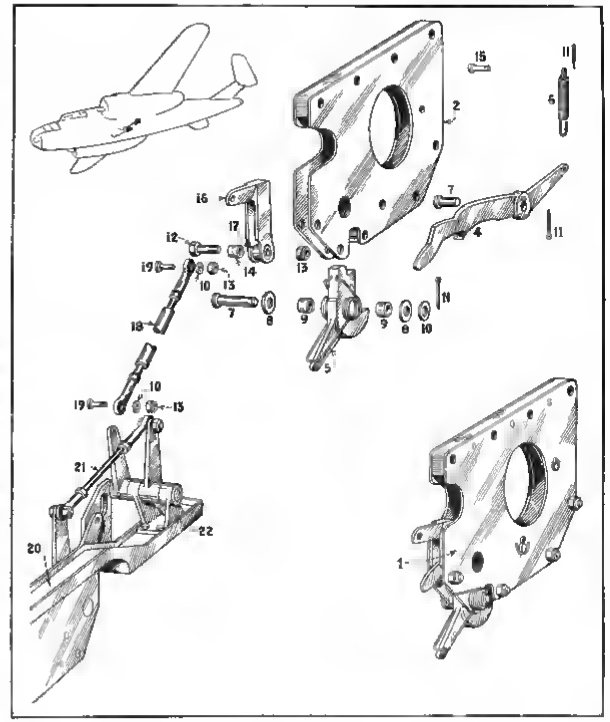


Fig. 12 "Exploded" assembly presentation of flexible fuel tank mechanism—one of thousands of perspectives employed by North American Aviation.

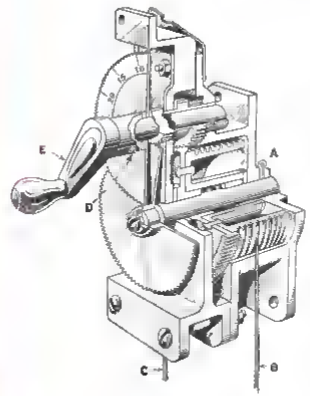


Fig. 13 Perspective of final assembly of tail control mechanism for Lockheed Aircraft Corp.'s *Lodestar*.

Will Your "FORTRESS" Be Ready On Time?

Think of the months of training and practice this bomber crew put in before they were ready for the real test.

ALTER EGO: And, think of the years of effort engineers and shop men put into the development of the "Flying Fortress" . . . all to enable the crew to rule the airways—to navigate in a bee-line to the destination, fight off "competition" all the way, hit the target and get home safely

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All of which is embodied in the practiced use of arc welding. There's our fortress for survival in the Battle for Business Let's start developing our welding knowledge NOW by consulting Lincoln.

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THE LINCOLN ELECTRIC COMPANY
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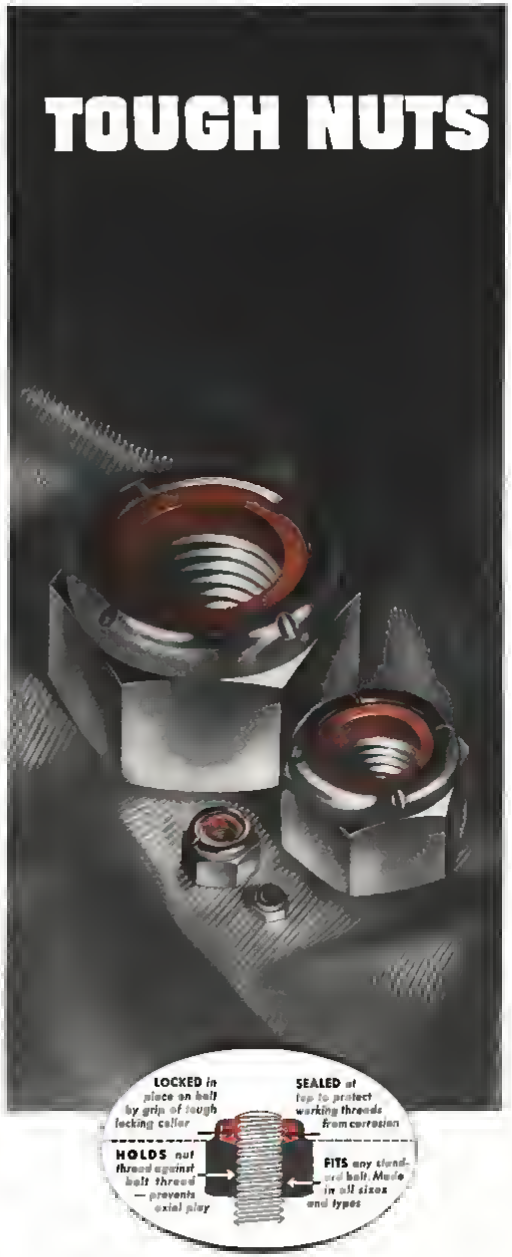
then I said to myself—

WELDED PRODUCTS HIT THE TARGET

OFFICIAL PHOTO U. S. ARMY AIR FORCES

TOUGH NUTS TO CRACK



● We've made billions of Elastic Stop Nuts.

And to our knowledge not one has failed to do its job.

But the tough nuts we refer to now are the fastening problems which looked hopeless until Elastic Stop Nuts were used.

We've met lots of these in our day — and licked them.

There have been plenty of them in war production.

And how well these fastenings have filled the bill can best be told this way:

Every nut we can possibly produce is going into war goods. Yet even doubling our round-the-clock plant capacity hasn't let us gain on the demand.

In the days to come there will be many peacetime needs for these nuts.

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Our engineers like to meet both kinds. They stand ready to share their experience with you, work on your fastening problem and recommend the proper Elastic Stop Nut application for the job

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Lock fast to make things last

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UNION, NEW JERSEY

Correct Use of Rubber Hose

By STANLEY S. KOGUT, *Eastern Aircraft Production Forum*

FACTORY MAINTENANCE

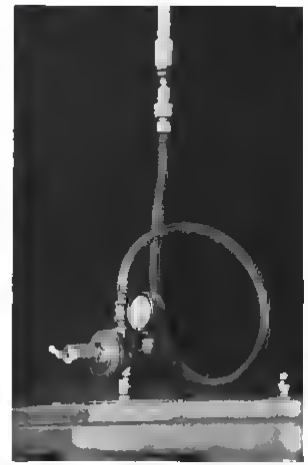
Rubber is one of our most critical commodities, yet in many aircraft plants rubber hose is one of the most thoroughly abused tools. This article tells how it should be handled and maintained for longer and more efficient service life.

Two very important considerations in putting a piece of hose into most efficient use are correct length and correct strength. All hose length above the actual amount needed is uneconomical. When a 30-ft piece of hose is used on a job where a 25-ft piece will work, no more efficiency is obtained. The cost of the extra 5 ft. is lost, the rubber contained in the hose is wasted, and very often the extra hose in the floor becomes a safety hazard unless some provision is made to keep it out of the way.

Conversely, about 50 percent of all original hose failure is at the coupling, caused by strain at those points from hose bending. Hose is made, for our consideration, in straight lengths. As with other rubber goods, any bend tends to set up a strain in the hose in proportion to the acuteness of the angle into which it is distorted. Depending on the severity of the strain, hose failure will occur at that point. By taking the angles of bend into consideration and allowing a generous radius that will not put tension in the hose, the life of the entire piece will be prolonged at the expense of a few extra feet. Stretching hose to "make it reach" causes premature failure.

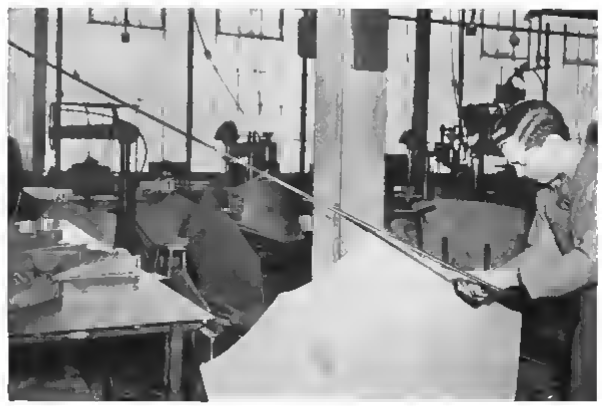
As to strength, manufacturers' recommendations should be followed. Hose must be strong enough to do the job, but it should be as light as possible consistent with this objective. A hose that is heavier than the one recommended is not generally advisable. Much more effort is required to haul it around or hold it, and its flexibility is considerably reduced by adding more plies or increasing its weight.

A workman treats a light hose gentler than a heavier one and a heavy hose is apt to decrease the efficiency of the man obliged to hold part of its weight consistently. Because a heavy hose cannot be bent as sharply as a light one, very often a longer length may be necessary. While it is true that a heavy hose may give longer life

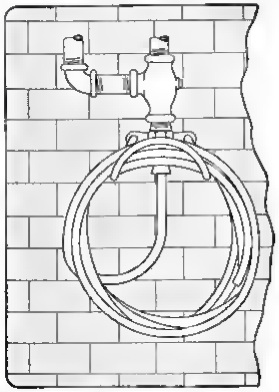


Correct Use. Hose is exactly right length to permit freedom of swing. Kinking and abrasive wear are avoided

Wrong Use. Hose is much too short. Tugging on hose causes excess strain, and sharp bends considerably reduce length of hose life.



Standard couplings should be used wherever possible to salvage hose pieces



When hose is not in use it should be hung on racks specifically designed for purpose—and never over nails, or the like.

Correct Use. Hose connected to overhead air line—long enough to reach work without strain or sharp bends, yet not too long to be wasteful of hose.

because of the additional abuse it can take, its inherent disadvantages are sufficiently great to outweigh anything gained.

Wrong Use. Hose lying across alleyways are quickly ruined by trucks and other vehicles. Furthermore, such hose lines represent a real industrial hazard.

Wrong Use. Hose is too long, drags on floor which causes rapid wear of hose covering. If air line elbow were turned upward, most economical length of hose could be used and at least one bend eliminated.

There is much to be said for using as few different kinds and sizes as possible. Less stock can be kept on hand and more efficient application may be made of it.

Hose Types

With some minor exceptions, almost all hose used in aircraft plants is for riveting, welding, or painting. Investigation may show that the same hose can be used for either riveting or welding, despite the fact that hose is often specifically labeled for one purpose or the other by manufacturers. If inside and outside diameters are the same, as well as number of plies, the hose may be used interchangeably even though it may be colored black, green, or red. However, if the hose tube is of synthetic rubber, its use should be confined to air lines because of the synthetic's resistance to oil which may seep through from the compressor.

Care and Use

Hose is packed carefully to keep it free of strains and kinks. It is packed in burlap or containers for protection. Unpack it with the same care put into its packing. A great deal of hose failure occurs when it is uncrated. The use of hooks, knives, or any tool that may pinch the hose, must be avoided.

Hose should be stored in a cool, dark place. If possible, do not remove it from its original containers. Heat and sun-light are particularly destructive, hence should be avoided. Ozone set up around electrical equipment is also very destructive, therefore rubber goods should be kept away from such equipment.

Rubber hose is subject to destruction

(*Turn to page* 362)

HUGH L. DRYDEN

MAJ. L. D. GARDNER

IGOR I. SIKORSKY

T. P. WRIGHT

11th Annual Meeting of Institute of Aeronautical Sciences

Second wartime assembly consisted of sessions held simultaneously in New York, Detroit, and Los Angeles. Speakers emphasize aerodynamics and operational problems.

WARTIME transportation difficulties prevented members of the Institute of the Aeronautical Sciences from holding their eleventh annual meeting in a single city this year. But these conditions could not hide the fact that American engineers are united in the common task of speeding victory through exhaustive research.

Sessions were held simultaneously in three places—Pupin Physics Laboratory, Columbia University, New York City; Rackham Educational Memorial, Detroit, and the University of Southern California, Los Angeles.

At the Honors Night dinner which inaugurated the New York meeting on January 26, Dr. Hugh L. Dryden, chief, Mechanics and Sound Division, National Bureau of Standards, was elected Institute president for 1943, succeeding Hull L. Hibbard. Institute fellowships were presented to ten outstanding men in aviation, and awards for notable contributions to the industry and the aeronautical sciences were made to Igor I. Sikorsky, Dr. Edward A. Selmenli, I. W. Reichelderfer, A. Lewis MacClain, and Edmund C. Wells. Elected honorary members were Rear Adm. John S. MacCain, W. A. M. Burden, special aviation assistant to the Secretary of Commerce, and T. P. Wright, director, Aircraft Resources Control Office, WPB.

Since the technical sessions were open to the public, not all papers submitted could be read because of censorship restrictions. Transportation difficulties also prevented many of the authors from attending the Detroit meeting. Their papers were read by other delegates.

From reports of correspondents who attended the three gatherings—particularly Dr. Arthur Kuhn in New York and C. S. Ricker in Detroit—AVIATION here presents the complete bibliography of papers accepted for the final program and the highlights of the principal addresses, which are listed according to session subjects.

SKETCHES BY ELIZABETH F. KORN

Aerodynamics

In considering the *Aerodynamic Problems of the Towed Glider*, Alexander Klemin (New York University) and W. C. Walling (Lockheed Aircraft Corp.) pointed out that if the airspeed of a plane is 350 mph., it will be reduced to 180 mph. with two gliders in tow. Furthermore, cruising range and maximum rate of climb are reduced. If the engine is a radial it must be more powerful and hence better cooled. But the payload, 4,000 lb. with one glider, will be increased to 18,000 lb. if three more are towed behind.

The stability of a plane in a predetermined path of flight, by recording the angle of bank in turns without loss of altitude, was calculated by John E. Gould, Jr. (Douglas Aircraft Co.) in a paper on *Maneuverability Criteria Through Turning Performance*. Developing the theoretical hypothesis of Theodore von Karman, Zbigniew Kizynobloski (Polytechnic Institute of

WILLIAM LITTLEWOOD

CHARLES H. COLVIN

FRED E. WEICK

JOSEPH S. NEWELL

C. Fayette Taylor

Irvin W. Caldwell

W. G. Brombacher

Milton Moore

Brooklyn) demonstrated how torsional and flutter is a factor of the critical velocity. One of his conclusions was that the value of rigidity to specific weight decreased in this order: Steel, magnesium, 17 S P. aluminum, spruce plywood, and solid spruce. Hence a desirable wing skeleton might be made of aluminum, covered with magnesium, and containing a steel aileron.

W. F. Gerhardt

Other papers submitted to the Aerodynamics section were:

K. D. Wood (Purdue University), *Aspect Ratio Corrections.*

John R. Weske and F. E. Marble (Case School of Applied Science), *Characteristics of Airfoils in a Cylindrical Axial Flow Grid.*

Production

Although the government may purchase $500,000,000 worth of military planes for a few years following the war, private plane sales will determine the ultimate business and financial condition of the industry, according to G. M. Gunman (Vega Aircraft Corp.) in his paper, *The Economic Transition of Aircraft Production*, he predicted that the maximum postwar private sales would probably be about 50,000 a year involving a sales volume of $100,000,000. Obviously such a wrench in the pocket book would shut many production plants.

A paper on *The Plastic Working of Magnesium Alloy Sheet* by C. E. Lehnhardt (The Dow Chemical Co.) offered many suggestions to production men. Covered were working temperatures, dies, suitable lubricants to insure perfect drawings, and the proper cleaning of the resulting pieces.

Recent developments in plywood– the fact that it can be formed in increasingly large sheets, improvements in resin adhesives, and the additional hardness and strength resulting from impregnation of the veneer with phenolic resins– were considered by Thomas D. Perry (The Resinous Products & Chemical Co.) in a paper entitled *Progress in Aircraft Plywood, 1941-1942*. He predicted that the efficient plane of the future would be constructed neither of all metal nor entirely of plywood but will be a combination of the two. A process of photoprint reproductions in aircraft tooling was described by Philip Taber (Brewster Aeronautical Corp.) in which templates are photoprinted from negatives made of translucent, sensitized paper mounted on glass.

Other papers presented to the Production session were:

Arthur M. Fitzpatrick (Simson Aircraft Division, Vultee Aircraft, Inc.), *Perspective Illustration as Applied to Aircraft Design and Production.*

Bureau of Aeronautics, Navy Department, *Organization of Graphic Management Control.*

Charles W. Morse

Design and Transport

In a paper on *Designing Aerodynamic Surfaces by the Use of Algebraic and Trigonometric Functions to Permit Easy Manufacture*, John J. Apfalelgm

B. C. Boeing

(Douglas Aircraft Co.) illustrated how the use of differential equations could be avoided by employing simple, coordinate sine and cosine functions of the angle of direction. This procedure has the advantage of reducing the number of constants to be calculated.

A plan for the application of a definite technique in the use of X-ray was made by L. W. Ball (Triplett and Barton) in his paper on *The Relation of X-ray Testing to Aircraft Design*. Procedures of photographing and interpreting plates must be adopted to what ever parts in published castings are being inspected. Occasionally only mechanical tests will detect flaws.

In the transport field, Dixon Spra (American Airlines) stated in *Engineering at Power Control and Altitude Selection in Airline Operation* that more horsepower (preferably 650 per engine) rather than less, results in greater cargo carrying capacity per plane despite increased gasoline consumption, hence reduces the number of ships and personnel required. His article also contained new material on pull-out and cruising heights.

Efficiency in long-range flying operations can be judged on two counts—by

(Turn to page 351)

Cooperation

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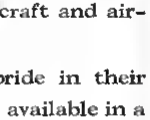

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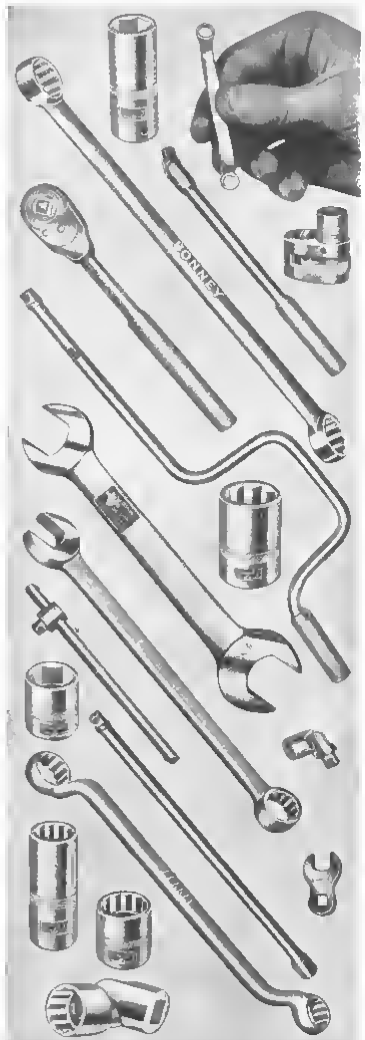

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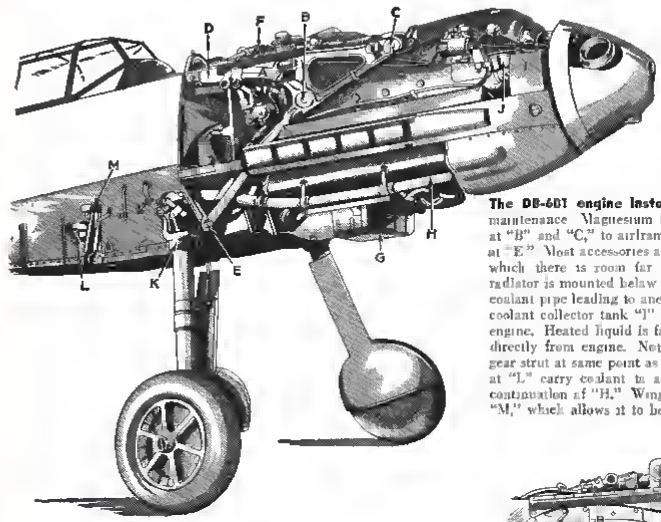
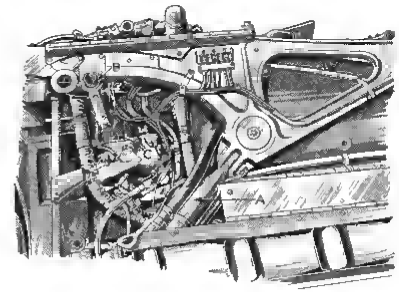
SKETCH BOOK OF DESIGN DETAIL

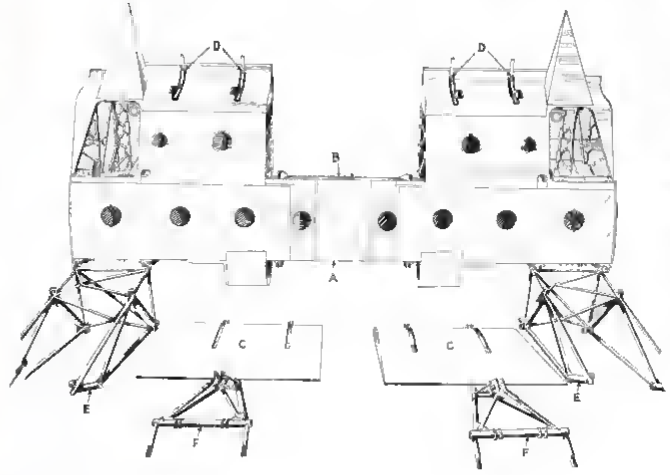
Beech Aircraft's AT-11 is a 4-5 place all metal lumber-crew trainer designed and being built in large quantities for the Army Air Forces and the Navy. Spars are of welded steel tube construction, and ribs and wing covering are aluminum. Landing gear including tail wheel, is fully retractable. Powered by two Pratt & Whitney *Wasp Junior* engines spinning Hamilton Standard constant speed propellers, it has a high speed of more than 215 mph.



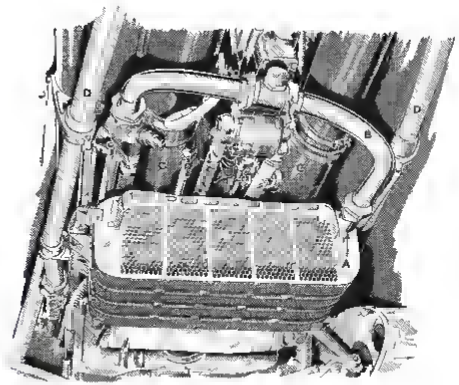
The DB-601 engine installation in the Me-109E permits easy maintenance. Magnesium forged mount "A" is attached to engine at "B" and "C," to airframe at "D," and through connecting strut at "E." Most accessories are mounted atop engine at "F," behind which there is room for mechanic to operate comfortably. Oil radiator is mounted below engine at "G." Above, at "H," is liquid coolant pipe leading to one wing radiator. This pipe comes from a coolant collector tank "I" located in a semi circle around front of engine. Heated liquid is fed into this tank from pipe "J" coming directly from engine. Note simple fitting "K" attaching landing gear strut at same point as bottom of engine mount "E." Two pipes at "L" carry coolant to and from wing radiator, upper being a continuation of "H." Wing is attached to fuselage through fitting "M," which allows it to be removed rapidly.



Detail at right of Me-109E engine mount shows lower strut attachment to fuselage at "A." Connection for hand starter is at "B," starter itself being located at "C."

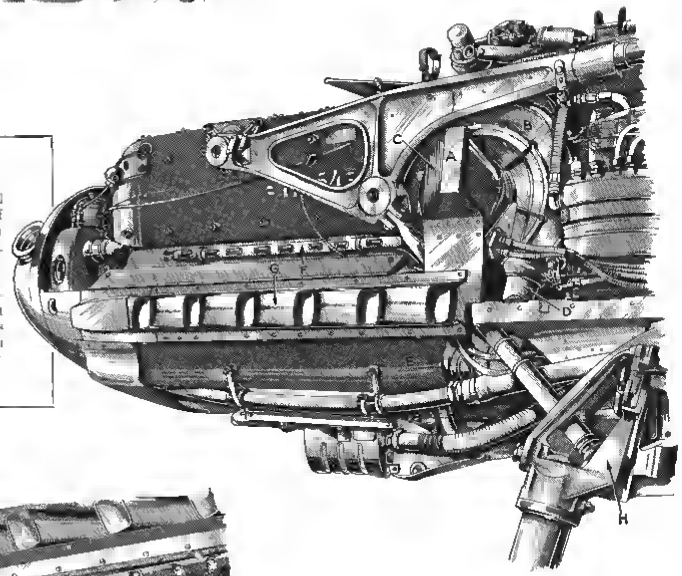


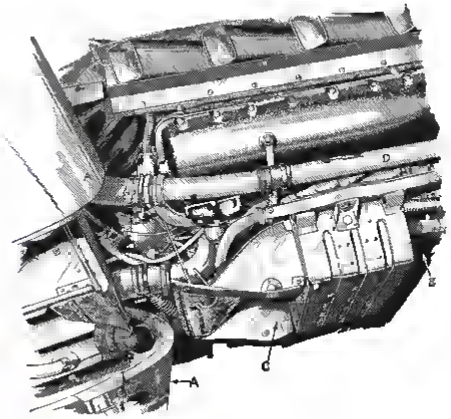
Shown here are details of center section, together with some of the few metal parts used in construction of Boeing AT-15 *Crewmaker* bomber crew trainer. Synthetic rubber bladder-type gasoline tanks are housed between front spar "A" and rear spar "B" tanks being put in place through access holes shown on under side of section. Inboard flaps "C," which are attached to fittings "D," are also of wood. Metal parts shown are engine nacelle framework "E" and landing gear draglinks "F" showing connection for retracting screw.



Installation of air radiator, which is set below engine at about wing leading edge on Messerschmitt 109E, is simple but effective. Oil enters radiator at "A" from pipe "B" coming from engine. Cooled oil is returned to engine through a pipe at rear of radiator. Also shown in illustration are intake manifolds "C" leading from supercharger to two cylinder banks. Pipes "D" take heated engine coolant liquid to wing radiators.

On Messerschmitt 109E, air intake "A" leads directly to geared supercharger "B." A series of right angle vanes "C" turn air smoothly into intake. After being supercharged, air passes down intake manifold "D" and into cylinders "E." Ignition harness follows along base of cylinders at "F" and above exhaust stacks "G." Note linkage mechanism "H" for retracting landing gear.



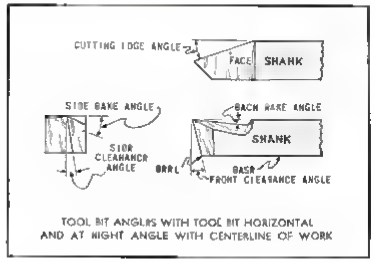


Side view of oil radiator installation on Me 109E shows location just ahead of wing leading edges "A." Cooling air enters radiator at "B," leaving at "C." "D" is pipe (also identified by same letter in front view) carrying engine coolant to wing radiator.

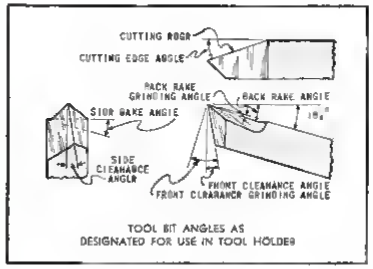
Tool Bit Design

Data for the Machining of Various Materials

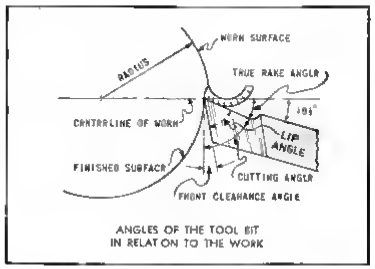
Official A. S. M. E. Designations of Tool Bit Angles



TOOL BIT ANGLES WITH TOOL BIT HORIZONTAL AND AT RIGHT ANGLE WITH CENTERLINE OF WORK



TOOL BIT ANGLES AS DESIGNATED FOR USE IN TOOL HOLDER



ANGLES OF THE TOOL BIT IN RELATION TO THE WORK

DATA FOR THE MACHINING OF VARIOUS MATERIALS

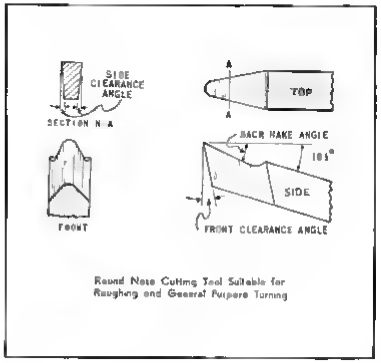
MATERIAL	Front Clearance	Side Clearance	True Back Rake (Tool Holder Angle)	Side Rake	Cutting Speed Feet Per Minute	LUBRICANT
STEEL (MILD COLD ROLLED)	8°	8°	16½°	22°	80 to 100	DRY OR CUTTING OIL
STEEL (MEDIUM HARD)	8°	8°	12°	14°	60 to 80	CUTTING OIL
STEEL (TOUGH ALLOY)	8°	8°	8°	12°	50	CUTTING OIL
CAST IRON	8°	8°	5°	12°	50	DRY
STAINLESS STEEL	8°	10°	16½°	10°	40	CUTTING OIL OR SULPHURIZED MINERAL OIL
COPPER	12°	14°	16½°	20°	120	DRY OR CUTTING OIL
BRASS	8°	8°	0°	0°	200 to 300	DRY OR PARAFFIN OIL
BRONZE	8°	8°	0°	2°	80 to 120	DRY OR PARAFFIN OIL
HARD BRONZES	8°	12°	10°	2°	30 to 90	DRY OR PARAFFIN OIL
ALUMINUM	10°	8°	35°	15°	200 to 500	DRY OR KEROSENE
MONEL & NICKEL	10°	13°	8°	14°	100 to 120	SULPHURIZED MINERAL OIL
MOLDED PLASTICS	12°	8°	0°	0°	100 to 120	TURN DRY THREAD WITH CUTTING OIL
CAST PLASTICS	14°	10°	0° to -5°	0°	150 to 200	TURN DRY THREAD WITH CUTTING OIL
FORMICA & MICARTA	15°	10°	16½°	10°	200	DRY
FIBER	15°	12°	0°	0°	80	DRY
HARD RUBBER	20°	15°	0° to -5°	0°	200	DRY OR COOLANT

These Angles Are Recommended by Competent Authorities. All Angles Are TRUE Angles Measured from Horizontal and Vertical Planes. Speeds Are Correct for Standard High Speed Tool Bits. Tools of Alloy Bits Permit a Somewhat Higher Cutting Speed

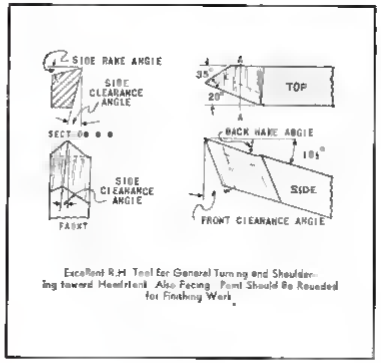
(Continued)

Tool Bit Shapes For Use in Tool Holder

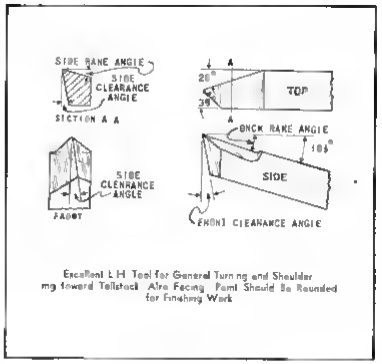
Note: These tool shapes are satisfactory for forged tools and tool bits held directly in the tool post but actual grinding angles must be changed



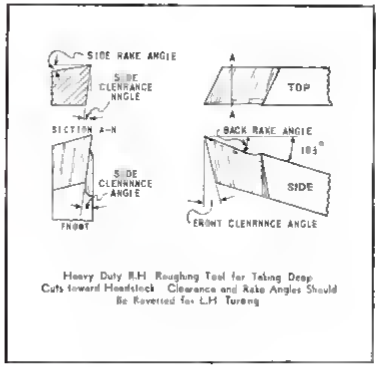
Round Nose Cutting Tool Suitable for Roughing and General Purpose Turning



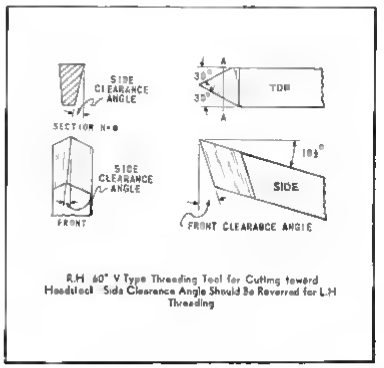
Excellent R.H. Tool for General Turning and Shoulder-ing toward Headstock. Also Facing. Point Should Be Rounded for Finishing Work.



Excellent L.H. Tool for General Turning and Shoulder-ing toward Tailstock. Also Facing. Point Should Be Rounded for Finishing Work.



Heavy Duty R.H. Roughing Tool for Taking Deep Cuts toward Headstock. Clearance and Rake Angles Should Be Reversed for L.H. Turning



R.H. 60° V Type Threading Tool for Cutting toward Headstock. Side Clearance Angle Should Be Reversed for L.H. Threading

Courtesy of Atlas Press Co.

Review of Patents

By A. HARRY CROWELL,

Registered Patent Lawyer

From time to time we shall present some of the more interesting recent patents in aviation developments granted by the U. S. Patent Office. Mr. Crowell will be glad to furnish AVIATION readers with free information on approximate cost and procedure in applying for patents and trade-mark registrations. Address inquiries to Mr. Crowell care AVIATION, 330 W. 42nd St., New York. Complete printed copies of any patents listed below are obtainable, at a cost of 10¢ each, direct from the U. S. Patent Office at Washington.

Universal Flight Indicator. Magnetic compass which, because of its characteristics, may also be utilized in aircraft as a universal flight instrument. Device designed both to give improved magnetic compass bearings and also to inform pilot of direction and attitude of flight. Magnetic compass also performs functions of an artificial horizon, directional gyro, and inclinometer. — 2,303,718, E. A. Sperry, II, assignor to Sperry Products, Inc.

Manufacture of Propeller Blades. Method of making propeller blades from a tubular steel blank. Comprises shrinking of blank on an arbor in such manner that external dimensions of blank will be unaltered to produce accurate predetermined curving and thicknesses by conforming internal periphery of blank accurately to periphery of arbor during machining operations so as to avoid distortion from predetermined wall thickness desired. Other improvements also embodied.—2,302,220, G. T. Lampton, assignor to Aviation Corp.

Cooling System for Engines. This is an engine unit wherein entire aeronautical engine is surrounded by an under static pressure within an air jacket or scoop, which preferably constitutes the cowling of the engine. Air scoop is entirely closed, except for restricted outlet therefrom leading around cylinders and through intercylinder spaces, with outlets of considerably smaller gross area than area of air intake opening.—2,302,208, D. B. Cox, assignor to Fairchild Engine & Airplane Corp.

Ski Attachment for Aircraft. Improved means for maintaining angle of attack of skis constant in relation to body of aircraft when latter is in flight. Skis are held at the proper flight angle by means of fluid pressure devices of cylinder and piston type.—2,302,343, R. B. C. Nicholson, assignor to Northern Aviation Ltd.

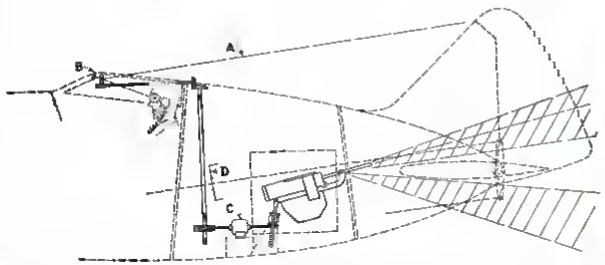
Rivet. A two-part rivet designed for use in airplane assembling which may be set by the use of a light hammer, and which is so constructed that clinching pin is incapable of working loose sufficiently to drop out of hole.—2,302,590, P. M. White, assignor to Atlas Supply Mfg. Co., Inc.

Speedometer for Aircraft. This speedometer is of type wherein a pressure of flow created within a venturi tube, or the like, is caused to actuate a diaphragm connected to an indicating or pointer mechanism.—2,302,713, J. G. Paulin.

Wing Unit for Aircraft. Device by means of which, even at large angles of incidence of total wing unit or of parts thereof, boundary layer is prevented from forming entirely by admission of a gaseous medium such as air to surface side of wing unit, and in which quantity of air to be removed to suction side of wing unit need not be very large. Slot spaces are provided in rear portion of wing in front of which movable flap or similar element, into which spaces air may be blown to influence boundary layer of flow.—2,302,025, B. von Schlippe, vested in Alien Property Custodian.

Seabag Device. An all metal seal for gas turbine plant conduit joints. Forces induced in seal by fluid pressure are utilized toward a more effective leak-proofness. It comprises a peripheral chamber extending around conduit on both sides of a joint in conduit flanges, together with an annular elastic metal seal located in chamber.—2,303,114, D. P. Eggel, assignor to Northrop Aircraft, Inc.

Differential Rudder for Airplanes. Combined directional and lateral control for airplanes, comprising a differential or split rudder for producing various combinations of turning, rolling, and banking



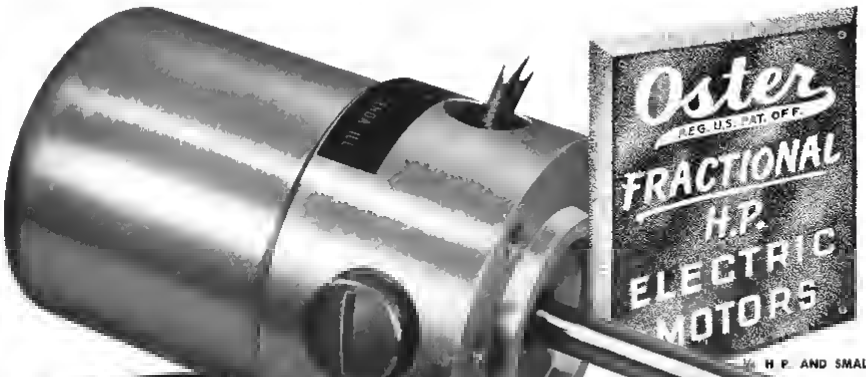
Multi-Aimed Machine Guns. Mechanism providing for operation of rearward-firing machine guns by pilots of single-place fighter planes is the development of John F. Halvelin who has assigned his patent, No. 2,304,566, to the Boeing Aircraft Co. Intended for defense against tail-attacking enemy craft, invention is briefly detailed in diagram above. Pilot draws bead on enemy plane along reflected vision line "A" via cross-haired mirror sight "B." This sight is integrated with train of gears operated by motor "C" which positions gun to fire in area either above or below elevator surfaces. There is provision for a switch element indicated at "D," to interrupt action of gun when empennage units are in line of fire. Pilot has control device to range mirror sight. Gun, as shown, is then automatically directed at area which is cross-haired in mirror.

Root Mounting for Rotor Blades. This is a root mounting in which peripheral compression of root portion of spar increases with increase of tension in spar resulting from centrifugal force.—2,303,707, C. G. Pullin and N. Stearns, assignors to Autogiro Co. of America.

Gust Flap Mechanism. Means for mounting linking and operating fluid flow flaps which form a part of a cowling for an aircraft engine, a trailing duct or the like. Invention consists essentially of torsionally stiffened flaps linked together by special hinge devices and means of producing such torsional stiffness in the flaps calling for attachment to their inside edges of a rigid frame in which one or more semi-annular leads are pressed.—2,303,712, R. Fuhlek, assignor to Consolidated Aircraft Corp.

Aircooled Aircraft Engine. Invention relates to aircooled engines which have cylinders arranged in line. It calls for cooling of the rear cylinders through space enclosed by engine cowling. One or more nozzles are provided in the lidge for leading cooling air current to front cylinders, while cooling air current for rear cylinders is admitted by nozzles provided in side wall of cowling.—2,303,797, W. Schlupp, vested in Alien Property Custodian.

Combined Recoil Drive. Here, internal combustion engine of aircraft drives a blower. Air compressed in blower passes partly to intake of cylinders of internal combustion engine, while remainder of compressed air is passed over engine cylinders to cool same. This latter air, thus heated preliminarily, and exhaust gases are then admixed. Next they are passed through a recoil nozzle, after which they expand in the atmosphere.—2,304,005, M. A. Mollet, vested in Alien Property Custodian.



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This selected information on new publications and products is offered by the "AVIATION" Reader's Service through cooperation with the manufacturers. It helps executives save invaluable time, provides profit through convenience. To obtain literature or additional data on new products described, simply fill in form below,* clip it to your letterhead, and mail. There is no cost, no obligation.

Re Silver Brazing 1
Available from Handy & Harman, New York City, is *Low-Temperature Brazing News No. 20* showing number of silver brazing applications of special interest to war production plants

On Mechanical Developments 2
Pointed to top executives interested in developing new mechanical ideas on parts or complete assemblies, *Ingenuity* is 38-page brochure offered by Sprisech Tool & Mfg. Co., Buffalo, N. Y. Facilities of company are described and profusely illustrated

Chains and Sprockets 2
Diamond Chain & Mfg. Co., Indianapolis, has published *Engineering Handbook No. 643* giving information on selection, installation, and maintenance of precision roller type chains and sprockets for aircraft use.

Ram Type Turret Lathes 4
Foster No. 6 universal ram type turret lathes are pictured and described in comprehensive 10-page bulletin newly issued by International Machine Tool Corp., Foster Division, Elkhart, Ind.

To Keep "Eggs" Out of Glue 5
Published by Casein Company of America, Division of Borden Co., New York City, is *Casco Trouble Shooter for Joint Gluing*. With wood glues now in wide use in aircraft industry, non-technical handbook is designed to help glue foremen and inspectors keep "bugs" out of gluing procedure.

Plane Lift Devices 6
Special folder of seven drawing plates issued by Globe Hoist Co., Philadelphia, describes firm's various heavy duty oil-hydraulic lifts for handling airplanes. Units are designed for plant production, service, and maintenance work on aircraft

Wheels Save Rubber 7
New shock absorbing "Floating Hub" wheel construction, developed as substitute for rubber by Bassick Co., Bridgeport, Conn., is described in photo- and diagram illustrated folder issued by firm. Casters and wheels are used on various portable equipment, and tests are being conducted on wheels suitable for airport trailers

Earth-Moving Feats 8
The Honor Roll is 180 page booklet in colors prepared by Caterpillar Tractor Co., Peoria, Ill. Liberally illustrated, it tells of feats of earth moving machinery in wartime, with numerous aviation applications featured.

Degreasing and Cleaning 9
From Oakite Products, New York City, is available second edition of *Oakite Cleaning Materials and Methods in the Aviation Industry*, 40-page booklet.

Expendable Glue Pots 10
Folder issued by Mono Service Co., Newark, N. J., tells of company's color-identified expendable safety glue pots designed to assure fresh glue, control quantity, and save labor time in aircraft plants

Self-Lube Pillow Blocks 11
Catalog No. 42, prepared by Randall Graphite Products Corp., Chicago, contains descriptions and specifications of self aligning and self-lubricating pillow blocks marketed by company.

Tool Catalog 12
Descriptions, pictures, blueprints, and specifications of Pes aircraft tools are contained in *Catalog No. 4* issued by Products Engineering Co., Los Angeles.

Thread Milling Procedure 12
Barber Colman Co., Rockford, Ill., is distributing *Facts About Multiple Thread Milling Cutters*, 140-page illustrated booklet designed to assist users of thread milling cutters in ordering and employing these machines. Book also explains causes and cures of thread milling cutter "ills."

Portable Hoist 14
Color-illustrated 8-page folder on its Midget King electric hoist has been printed by Yale & Towne Mfg. Co., Philadelphia. Descriptions, diagrams, and photos of adaptations of hoist are included.

Rheostats and Accessories 15
Ward-Leonard Electric Co., Mount Vernon, N. Y., offers *Bulletins 60A and 68* describing, respectively, its field rheostats and accessories and 4-in. pressed steel rheostats with rectangular and round contacts.

Drilling Handbook 16
The Portable Electric Drill, Its Proper Use and Care is title of handbook published by Black & Decker Mfg. Co., Towson, Md. Featuring numerous explanatory diagrams, 18-page manual is designed to train new workers.

Fluid Metal Cleaning 17
Bulletin titled *The New Synthetic Fluid Metal Cleaning and Conditioning* is offered by Solventof Chemical Products, Inc., Detroit. Stressed is new importance of cleaning and protection of airplane metal parts both in finished and semi-finished form. Company's washers are pictured and described

Circuit Breakers 18
New 40-page booklet by Westinghouse Electric & Mfg. Co. describes line of Nofuse "De-ion" circuit breakers for lighting, distribution, and power circuits up to 600 amp. Titled *Booklet DB-2F-060*, it explains De-ion arc quenching action, also gives facts on applications

Conveyor Systems 19
Moving production assembly lines, part conveyors, and dispatch tubes developed by Lamson Corp., Syracuse, N. Y., and widely used in aircraft industry are described and profusely illustrated in pamphlet *Watch Production Zoom* and folder *Wasted Steps Sabotage Production* newly issued by company

Bolts, Screws, and Pins 20
Catalog No. 101 is new publication on aircraft bolts, screws, taper pins, etc., offered by Aero Screw Co., Rockford, Ill. Items are described and diagrammed, and pertinent engineering data are included

Welding-Hood Glass 21
Folder available from Carter-Lockard Co., Los Angeles, deals with non-pitting Kleursite Koverglas originated by firm for use in electric welding hoods, spot welding spectacles, and acetylene welding goggles. Advantages over plain glass are cited.

New Drafting Medium 22
Helping You Get the Utmost From Your Projection Measuring Equipment is new booklet published by Industrial Engineer's Specialties Division, Universal Engraving & Colorplate Co., Buffalo, N. Y. It describes firm's paper on glass plates upon which engineers' drawings and diagrams can be scribed without fear of shrinking, stretching, or warping of the medium. Glass being translucent, diagrams may be placed directly on viewing screen of comparators. New medium makes possible work to decreased tolerances. Company has service for supplying duplicate transparencies, templates, etc.

Control-Unit Bellows 23
Thirty-two page catalog introduces Spring-Life metal bellows now marketed by Cook Electric Co., Chicago. New joined diaphragm construction is illustrated, and use of bellows as integral part of aircraft automatic temperature and altitude control units for assuring proper air and fuel mixtures is explained.

Ce Tool Grinders 24
Complete line of carbide tool grinders offered by Hammond Machinery Builders, Kalamazoo, Mich., is displayed and specified in *Bulletin No. 201* now being distributed by company.

Die-Less Duplicating 25
Fourth issue of its comprehensive catalog *The Die-Less System of Metal Duplicating Without Dies*, is announced by O'Neil-Irwin Mfg. Co., Minneapolis. A new model and several improved units are detailed among firm's various shearing, braking, and beading machines used in fabrication of special aircraft parts and devices

Substitute Materials Service 26
J. J. Berliner Technical Research, New York City, announces a comprehensive monthly loose-leaf service designed to keep subscribers informed on development and availability of substitutes and alternates for critical materials. Consultation service is also offered.

Magnesium Furnaces 27
Diagrams, photos, and description of magnesium melting, holding, and alloying furnaces supplied by Fisher Furnace Co., Chicago, are contained in firm's new *Bulletin No. 600*. Company's MAH furnace has recently been produced to accommodate a 4,400 lb. charge in magnesium alloy

Coolant Strainers 28
Introduction of Models G and H Metex coolant strainers is reviewed in circular issued by Metal Textile Corp., Orange, N. J., maker. For speed production with grinders and automatic screw machines, former unit has 15 to 60 gal. per minute capacity range, while latter affords 5 to 20 gal. capacity

NEW PRODUCTS

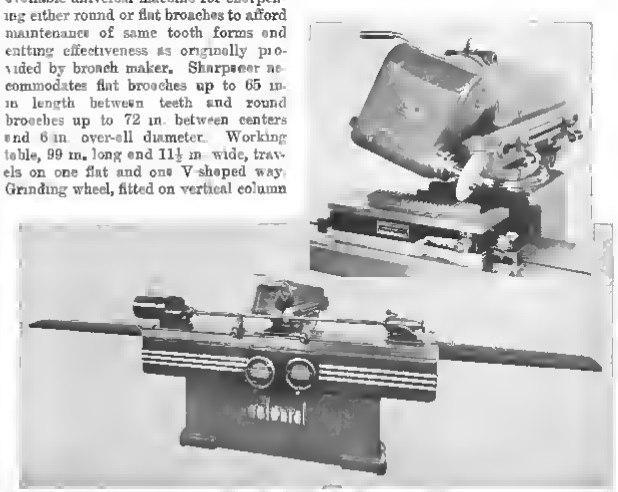
Metal-Stitching Machines 29
Harris Seybold-Potter Co., Dayton, Ohio, illustrates and details its Morrison wire stitching machines for fast aircraft assembly in a newly issued color folder. Units are designed for stitching aluminum and stainless steel

Electrical Contacts 30
Fansteel Electrical Contacts is new engineers' manual distributed by Fansteel Metallurgical Corp., North Chicago, Ill. An aid to electrical equipment designers, it contains details of contact metals, alloys, and powder metallurgy composition, together with selector chart, also covers rivets, screws, disks, segments, and special service contacts

Latest Machine Tools

Brooch Sharpener 31

From Colonial Broach Co., Detroit, is available universal machine for sharpening either round or flat broaches to afford maintenance of same tooth forms and cutting effectiveness as originally provided by broach maker. Sharpener accommodates flat broaches up to 65 in. in length between teeth and round broaches up to 72 in. between centers and 6 in. over-all diameter. Working table, 99 in. long and 11½ in. wide, travels on one flat and one V-shaped way. Grinding wheel, fitted on vertical column attached to machine bed, has 12-in. maximum travel, and its spindle, with speeds up to approximately 7,500 rpm., is belt



AVIATION READER'S SERVICE — MARCH

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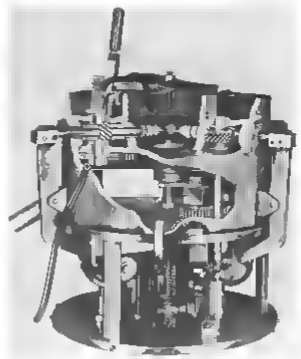
driven by ½-hp. 3,600-rpm. motor. Cross slide, mounted above graduated indexing support, provides 10-in. travel of grinding wheel spindle transversely to working table. Feature is use of two handwheels to provide three movements of grinding wheel head and work table. Rotation of handwheel on right moves table to right and left under grinding wheel head, while left handwheel has "In" position controlling horizontal feed of slide and grinding wheel head and "Out" position controlling vertical movement of grinding wheel head. Headstock and grinding wheel spindle motors operate on either 220 or 440 v. Weight of machine is about 6,800 lb. Photo of machine shows set up for round broach sharpening, while inset close-up depicts unit ready for "flat" or surface broach sharpening.—AVIATION, *March*, '43.

Mill-Drill Machine 32

Developed by **Adel Precision Products Corp.**, Burbank, Calif., is mill-drill machine designed for simultaneous drilling or milling of three or six holes or slots in small round parts, such as are used in hydraulic control valves and other mechanisms. Significant savings in time and labor are reported through combination of simplicity of operation, high speed, and precision. Upper body of



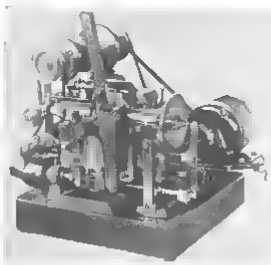
machine accommodates six evenly spaced spindles, six vertical drive shafts and, in the center, an oscillating mechanism. Lower portion, inclosed in split sheet metal cylinder, contains electric motor, reduction gears, and actuating cams for the six spindles. For drilling holes, parts are held in center fixture by lever-controlled clamp attached to upper table. For milling, an expanding arbor is inserted in center table and is actuated by T-shaped handle which protrudes from front of upper housing. Gear, linked to center fixture, produces oscillating movement of parts sufficient for end-milling tools to cut lateral dimensions as rocker arms move spindles toward center. Coolant system is remote, with inflow through adjustable tube and return flow directed by a stream sump through a drain pipe connected to a floor plate below six drill spindles.—AVIATION, *March*, '43.

NEW PRODUCTS

Motored P. & G. Cutter 33

As shown in photo (next page), pinion and gear cutter developed by **Waltham Machine Works**, Waltham, Mass., is now integrally motor driven. Moreover, other changes in unit, formerly primarily a pinion cutter, make it very suitable for cutting teeth, slotting tap screw ends, milling flutes and grooves, squaring tap and rod ends, etc. Built for single or multiple cutters, unit is adjustable for varying stroke lengths (⅛ to 1⅛ in.) and short strokes can be

NEW PRODUCTS



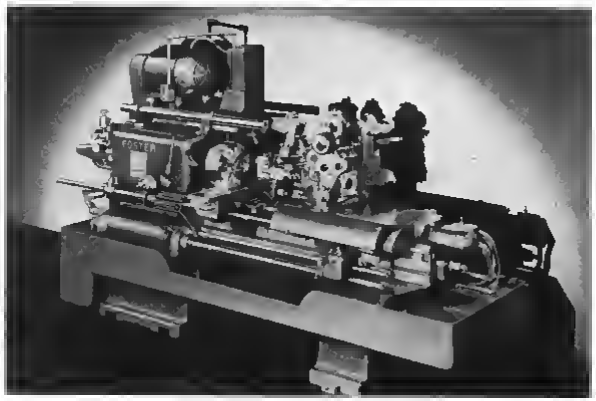
taken at any point of the work. There is automatic indexing for any number of positions and to care for uneven spacing. Machine can be arranged for either hand feeding or magazine feeding.—AVIATION, *March*, '43.

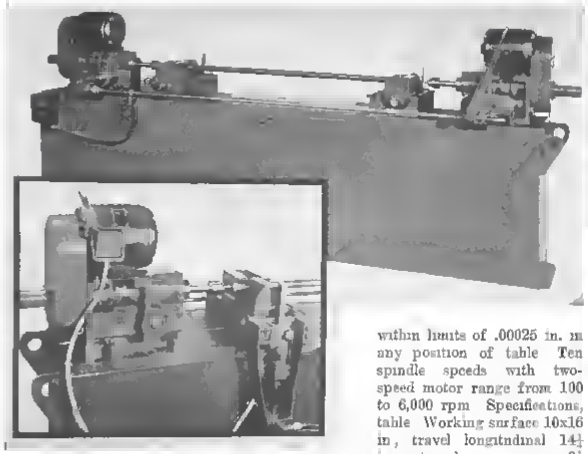
Turret Lathe 34

Designed for large volume of accurate turning and high production rate, Foster Fastermatic turret lathe, announced by **Foster Division, International Machine Tool Corp.**, Elkhart, Ind., is unit with entirely automatic machining cycle. Operator need only concern himself with loading and unloading work, hence may attend several machines at once, states company. Unit is equipped with flexible hydraulic feed system providing independent feed for each face of turret, thus time need not be lost in changing from one cut to another. Feeding mechanism, allowing multiple cutting in various combinations of machine movements, is built into machine. Oil pressure controlling feeding operation is adjustable from 300 to 1,000 lb. per sq. in. Coolant system is likewise built-in, and headstock is automatically lubricated by splash system and by means of oil pump forcing lubricant to bearings, gears, and shafts. Lathe comes in two models, 1-F and 2-F. Former has a range of 27 spindle speeds from 22 to 332 rpm. arranged in nine sets of three automatic changes. Either a 7½- or 10-hp. motor is furnished. Model 2-F has range of 28 spindle speeds from 17 to 263 rpm. arranged in seven sets of four automatic changes (higher speed ranges may be supplied when required). Here, 10- or 15-hp. motors are supplied, depending upon nature of work at hand. Motors are standard 1,800 rpm. and maintain speeds of drive shafts of 140 rpm.—AVIATION, *March*, '43.

Metallizer Unit 35

Metallizing Engineering Co., Long Island City, N. Y., announces its fusebond process and equipment for its application, whereby machine components and similar metal parts may be prepared for metallizing electrically. Feature is affording of adequate bond on hardened surfaces, while simplifying preparation of narrow edges, flat areas, and cylindrical parts having keyways, etc. Machine, operating on any 110 or 220 v., single-phase power line, fuses rough deposit of electrode metal into surface to be metallized. Special holder uses up to six electrodes at a time. Unit is contained in cabinet measuring 24 in. in height, while weight complete is 170 lb. Mounted on casters, cabinet which incorporates machine, is portable.—AVIATION, *March*, '43.



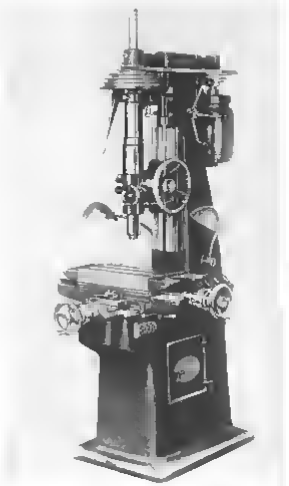


Centering Machine 36

Announced by **Pines Engineering Co.**, Aurora, Ill., is 2-spindle automatic centering machine for bars up to 6 ft. long. Both chucks are actuated by directly connected air cylinders, and one chuck and head are movable to accommodate different lengths of bars. For centering pieces from 18 in. down to 6 in. long one chuck is removed. Cam on lay shaft for advancing spindles actuate 4-way solenoid-operated air valve through limit switch to close chucks automatically, and adjustments align chuck jaws with spindles to compensate for wear. Capacity of chucks is 5-in. max. dia. round bars. In photos above, showing full machine and a close-up, guard which is regularly provided has been removed in order to show rack actuating mechanism for the chuck.—AVIATION, *March*, '43.

Jig Borer 37

Manufactured by **Moore Special Tool Co.**, Bridgeport, Conn., is jig borer designed for making tools and dies for such complex products as aviation instruments, and like fabrications. Unit is reported sensitive for holes of ⅛ in. or smaller and rugged for machine's maximum capacity, which follows. Two-speed motor for tool steel 3½ in.; soft steel 4½ in.; single-speed motor for tool steel 2 in., soft steel 2½ in. By means of two precision lead screws working at right angles to each other, work-pieces may be moved into any desired position in relation to fixed spindle, states company, thus making for accurate spotting, drilling, reaming, and boring in one uninterrupted sequence. Machine is designed to space and bore holes accurately within limits of .00025 in. in any position of table. Ten spindle speeds with two-speed motor range from 100 to 6,000 rpm. Specifications, table. Working surface 10x16 in., travel longitudinal 14½ in., travel crosswise, 9½ in., top to spindle end minimum 3 in., maximum 16 in., vertical adjustment of quill housing 9 in., spindle quill travel 3⅞ in., spindle center to column ways 9 in., and spindle center to column below ways 10½ in.



Company says ball bearings are doubly protected from dirt, with ample provision for oil. There are double "V" ways on the column to assure sustained perfect alignment of quill and spindle. Shipping weight of the jig borer (domestic) is listed as 1,900 lb.—AVIATION, *March*, '43.

(*Turn to page* 190)

THE *Right* INSULATING COMPOUNDS FOR EACH SPECIFIC JOB

another reason why

*unimold LEADS

(Integrally Molded)

ARE *SAFER, SURER, LONGER LASTING!*

Integral molding of the conductor is only one of the outstanding features of the TITEFLEX UNIMOLD detachable lead!

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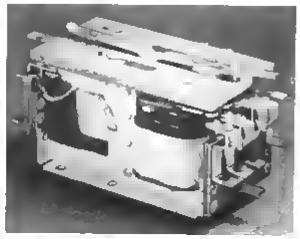
New Contactor 38

General Electric Co, Schenectady, N. Y., announces new three-purpose contactor known as Model CR2791-Q100. It is designed to start, reverse, and provide dynamic braking for d-c split field, series-wound aircraft motors, and is applicable to motors having full-load currents up to 10 amp and locked rotor currents of 60 amp at 12 or 24 v. d-c. Compact and light in weight, contactor



combines functions of several single purpose relays, with their interconnections and mechanical interlocks.—AVIATION, *March*, '43.

Asbestos Plane Parts..... 39

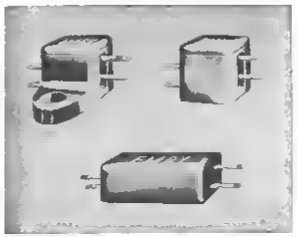
Mechanical Goods Div., United States Rubber Co, has announced through its New York Office development of aircraft fittings from asbestos fabric known as "Asbeston". Aim is replacement of critical metals. Fittings, some of which are seen in accompanying photo, are designed to withstand continuous heat of 350 deg. F. Advantages of sound deadening and resistance to vibration are cited. Uses already developed: Carburetor air intake, heater hose nozzle, defroster attachment, gun blast boot, heat register, turbo cooling fitting, air connector to supercharger, etc. In photo, W. F. Spoerl, of company, is seen examining piece of Asbestos fabric.—AVIATION, *March*, '43.

Oil-Wash Dust Collector 40

For collecting dust resulting from grinding, polishing, and similar operations on magnesium alloys, Claude B. Schneible Co, Chicago, has introduced its Multi-Wash system. In operation, metallic particles are immediately coated with oil, heavier particles being submerged in oil bath and carried away to settling tanks, while lighter or float dust particles are collected in the units. Feature is salvage of all metal dust.—AVIATION, *March*, '43.

Instrument Rectifiers 41

New instrument and relay rectifiers introduced by Emby Products Co, Los Angeles, are of selenium type utilizing unipolar conductivity of metal to selenium junction for rectification purposes. Units, stated by firm to be permanently stable, are offered in eight sizes with outputs ranging from 8 to 120 milliamperes. Of miniature dimension and light weight, they require no additional mounting brackets. Series "L" rectifiers are supplied in insulated metal cases, while series "S" come in unbreakable molded inclosures.—AVIATION, *March*, '43.



Traffic Zoning Paint..... 42

Offered by Thomson-Porcelite Paint Co., Philadelphia, is new traffic zoning paint to give highly permanent and visible markings on plant floors, air fields, parking lots, etc. Applicable by machine or hand-brush, company states paint dries in 20 to 30 min. and but one coat is needed for wood, stone, asphalt, wood blocks, composition, or cement. Available in white, yellow, and special shades to order, paint is shipped in 55-gal. drums and 5-gal. kits.—AVIATION, *March*, '43.

Screw-On Connectors 43

Wire-Nuts are solderless, tapeless wire connectors offered by Ideal Commutator Dresser Co, Sycamore, Ill. Firm states

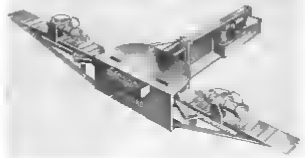
they need only be screwed on. Units conserve critical materials, since they do not use tin, lead, or rubber.—AVIATION, *March*, '43.

Leather Substitute 44

Cottonleather is name of new material developed by Southern Friction Materials Co., Charlotte, N. C. Semi flexible in nature and very dense, it is multiply fabric chemically treated for durability and surface-treated to give leather-like nature. Uses for friction applications, motor mountings, pipe and hose clamps, shock absorber blocks, and the like, are suggested. Material is available in planks, strips, and rolls in sizes from 1x⅛ in. to 6x⅛ in.—AVIATION, *March*, '43.

Bend-and-Bevel Unit 45

Hydraulic bending and beveling machine, here illustrated, has been introduced by Hufford Machine Works,



Redondo Beach, Calif. Unit was developed for handling extruded rolled and flat strips of all shapes and of many materials. It places workpiece under heavy tension and at same time

(*Turn to page 194*)

NEW PRODUCTS

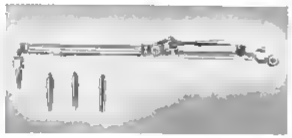
bends it around a form block on the Incorporated are stationary table carrying forming die and two simultaneously actuated arms hydraulically operated and hinged to table. Pivotal position of arms can be moved to accommodate workpieces of various radii. Specifications—Work capacity: length 12 to 200 in., cross section maximum size 7x7 in., cross section area approximately 3 sq. in. maximum, die width from 6 to 120 in.; Motor: 10 hp., 220 or 440 v., 3 phase; Hydraulic system, 2,000 lb. operating pressure; Shipping weight: approximately 12,000 lb.—AVIATION, *March*, '43.

Fluorescent Fixture 46

Delayed starting, flickering, and fluorescent failures due to starter troubles are stated to be eliminated with Insta-Lite, fluorescent unit introduced by **Spero Electric Corp.**, Cleveland. Ballast and starting switch functions are combined without use of additional starters. Industrial and commercial fixture is made for two 40-w. tubes, for 110-125 v., a.c. Unit is available in fixtures with non-metallic reflector, conforming to WPB limitation order L-78.—AVIATION, *March*, '43.

Cutting Torch 47

Rego Model NC cutting torch has been introduced by **National Cylinder Gas Co.**, Chicago. In addition to regular plate cutting, it is designed for fast handling of hole piercing, cutting rusty multiple plate, billet seaming, cast iron, and rivet washing. Mixing principle is stated to provide fast preheating, and over-size high pressure oxygen passage is designed to permit unrestricted flow of cutting stream to enable quick operation on all metal thicknesses. To make high pressure oxygen valve leakproof, diaphragm, rather than ordinary packing, is employed.—AVIATION, *March*, '43.



Sealed Resistors 48

Two new closed-cover, sealed variable resistors have been announced by **Stackpole Carbon Co.**, St. Marys, Pa. They are designed to perform under intensely humid or dusty conditions, either in standard radio or high-frequency equipment. Type MG is for extreme humidity or salt-spray conditions where internal and external leakage must be held to minimum. Type LP is furnished with dustproof cover and is sealed with special compound, thus is suitable for dusty or sandy localities.—AVIATION, *March*, '43.

Drum-Lifting Unit 49

Newly developed by **Ernst Carrier Sales Co.**, Buffalo, is 14-in. lift model carrier with built-in brake for placing and removing 55-gal. drums on and off skids, scales, and platforms. Safety feature is device which automatically lifts containers vertically into locked position on carrier.—AVIATION, *March*, '43.

Giant Portable Crane 50

Large portable crane, just brought out by **Barrett-Cravens Co.**, Chicago, has capacity of 4,000 lb. and lifting height of 20 ft. Over-all height is 22 ft., and boom length is 10 ft. Tele-

(*Turn to page* 197)

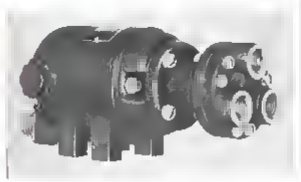
copic in construction, crane collapses to net lowered height of 13 ft. 9 in. Unique giant size of portable crane (see photo) is evidenced by comparison with nine men standing inside base forks.—AVIATION, *March*, '43.

Angle Vise **51**

Available from **Chicago Tool and Engineering Co.**, Chicago, is Palmgren angle vise specially designed for use in drilling, milling, grinding, filing, fitting, and marking operations. Unit is graduated for all angle work, states company, and quick accurate set-ups at any angle is feature. Swivel bases can be furnished for either bench or machine work. Vises come in sizes from 1½ to 8 in. jaws.—AVIATION, *March*, '43.

Metering Pumps **52**

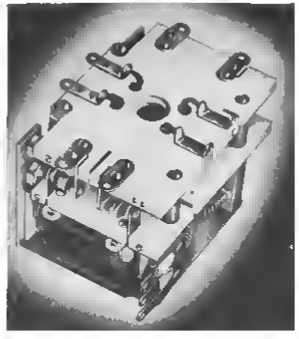
Fluid metering pump has been designed by **Weldon Tool Co., Cleveland**, as efficient light-weight pumping unit for aircraft industry. Built to AN specifications, pump is recommended for use with de-icing equipment on propellers, windshields, carburetors, etc. Pump and motor are separate units, either one being furnished independent of other. Over all length is 7⅞ in. and width (dia.) is 3½ in. over-all. In general, pump is direct drive, positive displacement, cam



type fluids metering pump It is not a vane type pump Weight of complete unit (pump and motor combined) is approximately 2½ lb Motor is a fractional horsepower, 24-v, d c, explosion proof type.—AVIATION, *March*, '43.

Aircraft Radio Relay..... 53

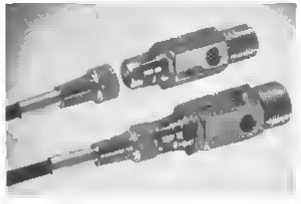
Model AK relay is high-speed keying and break-in unit for aircraft radio equipment. Designed for high voltage and resistance to vibration, relay has push-pull magnetic arrangement provid-



ing magnetic holding pressure on both "transmit" and "receive" contacts Features: Keys at 20 cycles, contact rating 1,000 v. at 30,000 ft (20 megacycles), 4-pole double-throw, insulated to sustain 10,000 v at sea level, standard models in 12 and 24 v d.c, wattage consumption 5 5 in first position and 17 0 in second position, dimensions, 2⅞x3½x 2½ in. and weight 17 oz. Maker is **Allied Control Co**, New York City.—AVIATION, *March*, '43

Pressure Pickups..... 54

New Pressure and detonation pickups for use with gas engines, pumps, compressors, and similar mechanisms, to record instantaneous pressures and other phenomena occurring within firing or compression chambers, are available from **Electro Products Laboratories**, Chicago Magnetic pickup has diaphragm which is exposed to explosion



of pressure forces within the cylinder, and resultant vibration produces magnetic flux variations in coil assembly, which provides output voltage having identical characteristics to varying pressures developed in cylinder. Models available are No 3000 and No. 3000A Former fits into hole in cylinder which is tapped to receive a ⅜ in. thread, while latter fits standard aircraft engine 18-mm spark plug hole.—AVIATION, *March*, '43

Rivet Squeezers 55

Line of rivet squeezer sets, made of National Emergency steel and available for all standard size round and brazier head rivets, as well as flush riveting operations, is announced and included in new catalog issued by **Aircraft Tools, Inc**, Los Angeles. They

are used with either hand or pneumatic squeezers.—AVIATION, *March*, '43

Pilot Light Assembly 56

Marketed by **Drake Manufacturing Co**, Chicago, is new No 675 type jewel pilot light assembly Of heavy-duty construction, double contact candelabra

bayonet socket is housed in thick black Bakelite base. Unit is designed for horizontal mounting on panels up to ½ in. thick. Amber, blue, green, red, white, and yellow colors are available. Slip-fit bezel, holding jewel, permits easy removal of lamp from panel front. Bulb sizes C7, G6, S6 or T4½ can be used.—AVIATION, *March*, '43

Reset Timers **57**

Units newly introduced by **R. W. Cramer Co.**, Centerbrook, Conn., are Models RS4 and RS5 reset timers. Synchronous motor-driven, they are available for time ranges up to 5 hr., longer if desired. High accuracy in timing of electrical circuits, machinery operation, heating processes, and the like, is reported by company. Both models operate on single pole, double-throw switch with capacity of 10 amp. at 115 v. or 5 amp. at 220 v., a.c., non-inductive loads, and will control 1/3-hp. motor loads, heater load of up to 1,200 w., lamp load of up to 250 w., or relay load which does not exceed 15 amp. inrush at 115 v. a.c.—AVIATION, *March*, '43

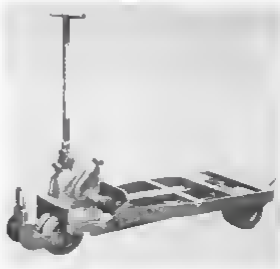
Triple-Basket Cleaner **58**

Individual cleaning of different types of parts during same run is

enabled with new triple basket devised by **L. & R. Mfg. Co.**, Newark, N. J., for its industrial clean-rinse-polish-dry machine. New basket fits snugly into regular work basket of machines, and being of fine mesh, most minute parts cannot slip through to become mixed with other items.—AVIATION, *March*, '43.

Train-Trailer Truck **59**

Load King trailer type hand-lift truck



has been developed by **Yale & Towne Mfg. Co.**, Philadelphia, for train-trailer materials-handling operations. Units have safety self-coupler attachments front and rear, and when not operating

(*Turn to page* 204)

Photographs by U. S. Army Air Force

Beechcrafts at Work

No. 1 OF A SERIES

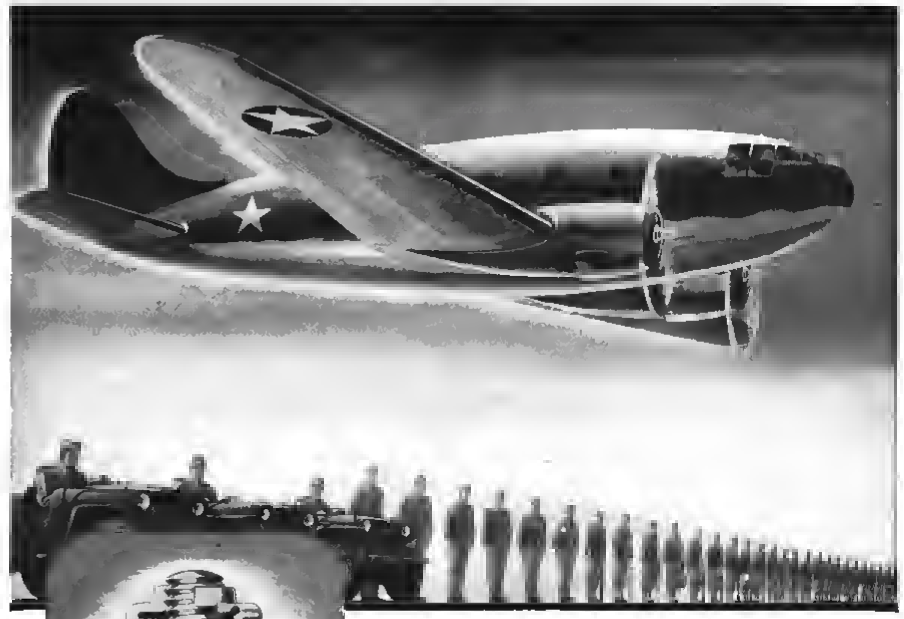
The AT-11 Beechcraft two-engine Bombing Trainers, shown above, serve the Army and Navy by providing a means of training bombardiers and bombing pilots in actual bombing operations. They are provided with all of the bombing equipment carried by even the largest bombers, except that their bomb-bays are smaller and carry less weight.

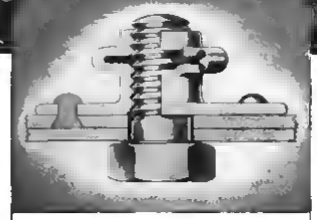
The AT-11's combine high operating speed, long range, and excellent flight and landing characteristics. They thus permit high-speed bombing runs, by day and by night, at high altitudes and low altitudes, without the imposition of abnormal burden on the skill of their pilots.

The use of the AT-11's as specialized Bombing Trainers is only one of the many examples of how the Army and Navy are providing their future combat pilots and bombardiers with the finest training in the entire world.

Beech Aircraft CORPORATION

BEECHCRAFTS ARE DOING THEIR PART — WICHITA KANSAS U. S. A.





A Self-Locking Thread

The Boots Self-Locking Nut is one-piece, all-metal—withstands severest vibration. The top (locking) section is displaced in a downward direction so that its locking threads are out of lead with the load carrying threads of the lower section.

Upon the insertion of a bolt, the top section of the nut is extended to engage with the threads of the bolt. A constant force is thus established which locks the nut firmly into position without damaging bolt or nut. Axial thread play is eliminated.

50,000 LBS... PROTECTED BY A THREAD

It's mighty important that the threads on the nuts which hold together vital parts of the Commando troopship should be dependable . . . that they be proof against even the most severe airplane vibration.

Boots All-Metal Self-Locking Nuts are used on these largest of all twin-engined cargo planes. They are unaffected by vibration—literally "outlast the plane."

Boots Nuts weigh less than other self locking nuts . . . thus they make it possible for the Commando to carry more cargo. And they have greater reusability in maintenance.

Boots Nuts meet the exacting specifications of all Government agencies, are used on all types of planes.

The new Boots "Rol-Top" Nut, all-metal, has special advantage for engine application.

BOOTS

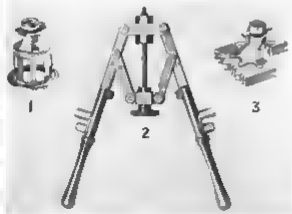
Self-Locking Nuts For Application In All Industries

BOOTS AIRCRAFT NUT CORPORATION ★ GENERAL OFFICES, NEW CANAAN CONNECTICUT

as trailers, they may be used as conventional type hand-lift trucks. Truck is adaptable to handling all types of loads on skids, bins, dump body skids, as well as special type skids, utilizing conventional skid platform and pallets. To break train of trucks, operator merely steps on pedal pad of latch casting.—AVIATION, *March*, '43.

Nut Binds Metal to Wood 60

Developed by **Boots Aircraft Nut Corp**, New Canaan, Conn., is new speed-up nut for use in plywood plane and glider production. Called the Self-Locking Cage nut, it is seen at "I" in



accompanying illustration. Specific use is fastening of metal to wood. Basket mount of this nut is "collapsed" with special clinching tool (photo "2") so that plywood will be clinched, as shown in photo "3", in a claw-like grip. Clinching tool sets mount into plywood or plastic from thicknesses of ⅛ in. up.—AVIATION, *March*, '43.

Surface-Angle Plate 61

Device stated to speed up inspection on production operations with controlled accuracy and avoidance of errors within tolerances as close as .00005, is announced by **Thomas Wilberton & Co.**, Cedar Grove, N. J. A combination master surface-angle plate, it is available in bench and floor models, both guaranteed within .0001 tolerances. Bench model weighs 145 lb., has angle plate 10x10 in. and surface plate 14x16 in.—AVIATION, *March*, '43.

Rubber Substitute 62

Butex compound, synthetic substitute for rubber, is offered by **Lights, Inc.**, Alhambra, Calif. It is described as tough, resilient, and resistant to oil, gasoline, chemicals, and age. Company will deliver it in molded, fabricated, or bonded parts, made to customer's requirements.—AVIATION, *March*, '43.

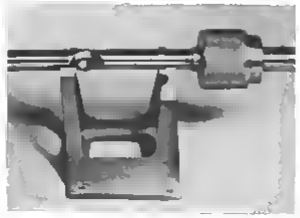
Gear-Cutting Unit 63

Michigan Tool Co., Detroit, announces new gear-cutting tool which despite small size (see photo) comprises 6,408 sharp

cutting edges. Cutter finishes gears by crossed-axis gear shaving principle, is specifically intended for both high accuracy and speed in war production.—AVIATION, *March*, '43.

Burr Remover 64

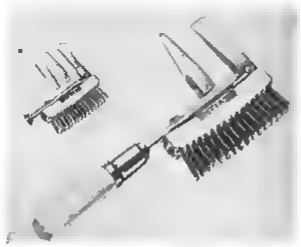
Marketed by **Nobur Mfg. Co.**, Los Angeles, is new burr removing tool, seen in accompanying photo applied to cutaway aileron pulley bracket to show specific operation. Tool has



special blade ground for a two-step diameter, burring outer space and inner shoulder of ball bearing seats simultaneously. Tool is available in ⅛ in progressive sizes from ⅛ to 1 in.—AVIATION, *March*, '43.

Weld-Cleaning Tool 65

Dual-Tool is weld cleaning unit introduced for use in aircraft plants. Maker is **Atlas Welding Accessories Co.**, Detroit. Device combines wire-bristle



brush and slag-removing bit in one unit, has holder permitting easy removal of brush for reversing or replacement. Models to meet specific requirements are offered.—AVIATION, *March*, 43.

Cathode Ray Oscillascope... 66

For extended frequency measurements, **Radio City Products Co.**, New York City, announces new cathode-ray oscilloscope Model 555. Unit employs 5-in. cathode-ray tube operating at 2,000 v. Permissible input voltage to amplifiers is 600 v., and direct to deflection plate 500 v., rms. Sweep frequency is from 40

cycles to 750 kilocycles in ten uniformly linear steps. Through use of comparison method with internal voltage source, unknown peak inputs can be read on direct indicating multi-range voltmeter. Instrument operates from standard 150 to 230 v., 50 to 60 cycles a.c. power supply.—AVIATION, *March*, '43.

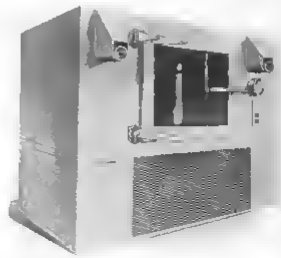
Gage Blocks 67

Announced by **Savage Tool Co.**, Savage, Minn., are Doall master gage blocks of which standard set, designated as No. 400, consists of 81 blocks ranging in length from .050 to 4.00 in. Blocks are produced in AA grade, accuracy .000002 in.; A grade, accuracy .000004 in.; and B grade, accuracy .000008 in. Each block has measuring surface of mirror finish lapped to flatness of less than the quarter wavelength of light, enabling blocks to be wrung together in combination to secure practically any dimension in steps of .0001 in. from .1000 in. to 12.00 in. Photo shows inspector checking a 4-in. micrometer.—AVIATION, *March*, '43.

NEW PRODUCTS

Instrument Tester 68

For testing instruments and materials, **Kold-Hold Mfg. Co.**, Lansing, Mich., offers new Hi-Low machine (basic Model 3600 HL illustrated). Offered in three temperature ranges for testing of



aircraft instruments and other devices, machine is entirely self-contained, requiring only source of electrical power. Temperature ranges are from —60 deg., —80 deg., and —90 deg. F. to 170 deg. F. Quick changes of temperatures for tests are feature.—AVIATION, *March*, '43.

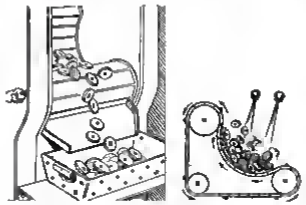
Insulation Remover 69

Developed by **Osborn Mfg. Co.**, Cleveland, is "soft-as-velvet" brush for removal of insulation from very fine wires in radios and other electrical

instruments. Made of steel wire, brush has 240,000 wire ends on its surface. In form of cylinder, this rotary unit is 1¼ in. dia., and 2 in. long, employs mild steel wire .0025 in. thick. In operation, brushes are mounted on spindles arranged so that they run parallel in order to clean entirely around wire, removing insulating material without marring copper underneath.—AVIATION, *March*, '43.

Parts Washer 70

American Foundry Equipment Co., Mishawaka, Ind., has new small parts washer, designed around special endless-tumbling belt and known as the

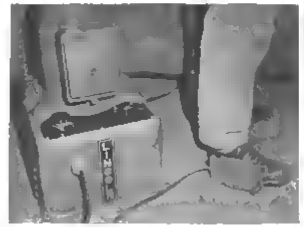


Tumbl-Spray. This batch-type machine, similar in action to rotary drum cleaners, receives and discharges parts to be cleaned through large front opening. Unit is available for heating with steam, gas, or electricity and can be supplied with full automatic control. Procedure is revealed in diagram, with unloading by reverse run depicted on left and washing action shown on right.—AVIATION, *March*, '43.

NEW PRODUCTS

Pedol Welding-Control 71

Lincontrol, new type of arc welding control designed to speed up work, is announced by **Lincoln Electric Co.**, Cleveland. Device is strapped to foot, allows welder to move about with it freely. Operator merely presses down on pedal, which moves pin to operate a current control. As he exerts pressure, he increases current. Unit is de-

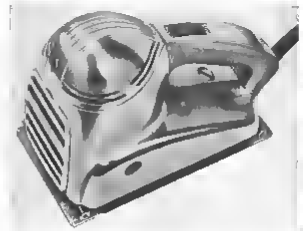


signed for company's Shield-Arc Junior welders, and standard Junior models may readily be adapted.—AVIATION, *March*, '43.

Heavy-Duty Sander 72

Model 1000 is new electric sander designed by **Sterling Tool Products Co.**,

(*Turn to page 210*)



He'd be wearing an "E" pin too . . . if he were home

They gave him a gun and taught him how to shoot it. No need to tell him *why!* He's an Adlake man—one of many Adams & Westlake employees in the armed forces of our country. As such, he needs no prompting to play the vital role to which a threatened nation has assigned him.

If he were home today, he, too, would proudly wear an Army-Navy "E" pin. For his former fellow workers—men, women, and management of The Adams & Westlake Company—have recently won the Army-Navy Production Award "for high achievement in the production of materials of war." They, too, need no prompting in the accomplishment of their assigned tasks!

We of Adlake look upon the "E" pins we wear—and upon the Army-Navy "E" pennant which floats above our plant—as a challenge to strive still harder to hasten Victory. We know that every Adlake man in uniform is doing his dead-level best. We, his friends at home, will not let him down!

Adlake TRADE MARK

THE ADAMS & WESTLAKE COMPANY

ESTABLISHED IN 1857 — ELKHART, INDIANA — NEW YORK CHICAGO

MANUFACTURERS OF ADLAKE SPECIALTIES AND EQUIPMENT FOR RAILWAY, AIRWAY, HIGHWAY AND WATERWAY

DWARFED BY A MATCH!

A low-flying plane, aiming itself at an enemy cruiser—o lever pulled and a long, sleek torpeda drops into the woter and rushes destruction taward the enemy.

But all must be right with the big tin fish!—the motor running smaothly and the fuse already for the smash into the side of the ship. Tiny mechanisms, more accurotely made thon any watch port, assure the success of the aHack.

VINCO occuracy in the manufocture of fixed limit checking devices, is well known throughout the long list of war producers. For example, the gage at the left hos proven accuracy of less than .0001 error, yet is smaller than a match stick. Parts checked with gages as accurately made as this, must aperate smoothly and surely.

From a weight of an ounce to a weight of many paunds, VINCO gages oll have the same VINCO accuracy.

If you have a gaging problem, VINCO can help you.

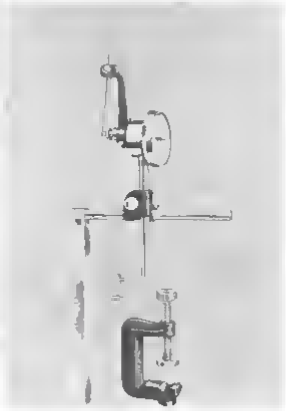
VINCO CORPORATION

8865 SCHAEFER HIGHWAY
DETROIT • • MICHIGAN

Chicago, for heavy-duty service. Sander is described as streamlined balanced and counterbalanced vibrationless unit powered by ½ hp. motor and cooled by turbine type fan. Susp-action switch is located on handle. Sanding pad takes one-third sheet of standard abrasive.—AVIATION, *March*, '43.

Testing Device 73

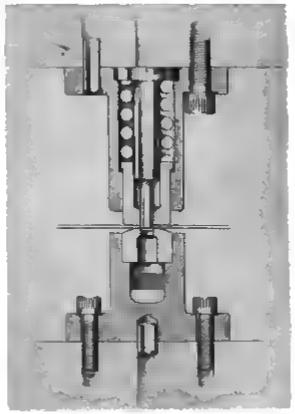
Universal test indicator No. 22A is offered by **B. C. Ames Co.**, Waltham, Mass. Device, stated to be small, compact, and easy to set up and adjust, is designed for numerous testing jobs, and with hole attachment can reach internal surfaces usually inconvenient. Complete set (illustrated) includes: Indicator No. 101H, three contact points of different lengths, indicator holding rod, hole attachment, tool holder, upright



spindle, sliding swivel, and "C" clamp. Held to base with a wire, indicator's bezel is easy to remove, provides a smooth turning motion.—AVIATION, *March*, '43.

Hole Punching Units..... 74

Latest addition to line of punching and notching equipment, offered by **Strippit Corp.**, North Tonawanda, N. Y., is new set of punch and die devices known as Wales TB unit. Designed for use in conventional die set, punch unit



half contains a punch with pilot, holder, stripping spring, and guide. Die unit half consists of holder with slug clearance chute and die. Each unit is self-contained and independently mounted to either punch or die shoe, thus making every punch or die holder easily accessible for changing individual punches and dies. Each holder and die holder has pilot pin centered on punch or die to automatically assure perfect punch and die alignment. Unit may be mounted on template which slides into position and is bolted to shoes, with special ring fitting over die to align punch and die to template mounting. Units are used in either punch presses or press brakes to punch holes from ⅛ to 2½ in. dia. in metal up to 11 gage. Accompanying view through unit shows stripping mechanism and location of pilot pin in die holder.—AVIATION, *March*, '43.

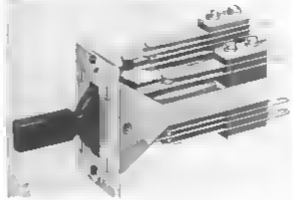
Magnifying Scale 75

Machinist's scale equipped with adjustable magnifying lens is product of **Leonard Engineering Co.**, Silver Springs, Md. Known as the Micro Scale, it consists of standard machinist's scale

graduated in 64ths of an inch and incorporating magnifier with unbreakable plastic lens mounted on slide block. Designed to expedite measuring operations, scale folds to fit flat in pocket.—AVIATION, *March*, '43.

New Switch Device 76

Lever switch newly developed by **Donald P. Mossman, Inc.**, Chicago, is Model 0-42. Primarily it is for communication, specific radio, and testing apparatus uses, also wide range of industrial applications. Small and light in weight, unit is available in many series of combinations of contact assemblies. It is stated to feature positive action—locking, non-locking



(spring returns to neutral position), and no throw stops. Ratings: Maximum recommended 5 amp., 110 v. a.c. (non-inductive). — AVIATION, *March*, '43.

Lapping Plate 77

New lapping plate is announced by **Smith Tool & Engineering Co.**, Bucyrus, Ohio. It is designed for developing true plane of close tolerance, in order to assure perfect fit when lapping metal-to-metal joints and other uses requiring accurate flat-lapped surfaces. Units are constructed, states company, for maximum rigidity and stiffness with minimum deflection. Standard sizes range from 8x12 in. to 48x120 in.—AVIATION, *March*, '43.

Coolant Pumps 78

Available from **Atlas Press Co.**, Kalamazoo, Mich. are two new compact portable coolant pumps adaptable to machine tools and designed for high production demands. Pumping capacities are stated to meet maximum flow requirements of most makes

of lathes, drill presses, millers, grinders, cutoff saws, screw machines, and single and multiple-spindle drilling and tapping machines. Models are designated Nos. W89 Universal and W88 Induction. Former has 5-gal. capacity, latter 2½-gal. Both have overall height with motor of 8½ in.—AVIATION, *March*, '43.

Pedal Hydraulic Press 79

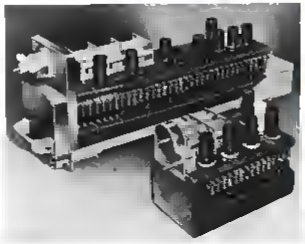
Provision of pressures to 20,000 lb. via foot controls, leaving operator's hands entirely free, is feature of Speedpress, new hydraulic arbor press, announced by **Studebaker Machine Co.**, Chicago. Designed for fast operation, unit has no hand levers. There are three pedals, one to send ram downward to contact work, second to hold grip desired, and third to release pressure, returning ram automatically to top of travel. Machine is for broaching, assembling, piercing, oil-grooving, riveting, sizing, flanging, staking, forcing, small die tryouts, forming, pressing operations, and the like. Specifications—Diameter of work, 15¾ in., largest arbor (size of opening in base for arbor work) 6 in., capacity over table plate (to ram in highest position) 11⅞ in., ram stroke, 7 in.; table platen, 7½ by 8 by 1⅝ in.; shipping weight (press, platen, and foot control) 303 lb.—AVIATION, March, '43.

Plastic Paint 80

Calumet Plastics Co., Hammond, Ind., offers liquid plastic paint, stated to expand and contract with changing temperatures, suitable for interiors, exteriors, concrete floors, etc. Firm says cracks, splits, and joints of reasonable size remain sealed by this plastic bond, and that painted surfaces become nonporous and impervious to penetration of dirt and moisture. Product may be applied by either brush or spray.—AVIATION, *March*, '43.

Simplified Radio Receiver ... 81

New method of assembling radio receivers from three basic cells, using only one type of tube in entire circuit regardless of its complexity, is announced by **Electronics Div., Harvey Machine Co.**, Los Angeles. Called Unitized radio receiver, set is assembly of four or more "cells," each cell being complete element of radio circuit. Three types of cells are produced—RF, IF, and audio amplification. Construction is stated to eliminate approximately 95 percent of hook-up wire usually required. Unskilled operator, says company, can replace cell to effect repairs, without need for solder, circuit diagrams, or radio experience. Illustrated is 4-cell receiver, for mobile equipment, and behind it is 9-cell unit incorporating automatic direction finder and four frequency bands.—AVIATION, *March*, '43.



Feeling Pump 82

Turbine-type pump for aviation fueling systems, such as employed at air bases, is marketed by **Deming Co.**, Salem, Ohio. Units, which also may be employed in industrial applications, is designed to handle 100 octane aviation gasoline as well as lower grades of gasoline and fuel oil. Usually mounted on storage tanks located below ground, pump is self-venting and cannot become vapor locked. Regularly furnished with totally-inclosed, explosion-proof vertical motor, pump has carrying capacity ranging up to 1,000 gal. per min. Units are shipped completely assembled except for mounting of motor.—AVIATION, *March*, '43.

New Skin Fastener 83

From **Scovill Mfg. Co.**, Waterbury, Conn., comes initial announcement of a new type skin fastener described as featuring a higher safety factor, new speed of operation, and less worker fatigue. Known as the Loxit fastener, the new unit has been checked, at the request of the maker, by a technical laboratory, and the results of these tests are being made available by the company. Further details and an illustration of the fastener will be supplied in these columns next month.—AVIATION, March, '43.

Want to Increase Welding Speeds 15%?

THAT'S WHAT MANY MANUFACTURERS HAVE DONE BY CHANGING TO A-C WELDERS*

WITH a-c welding, arc-blow is seldom troublesome, therefore larger electrodes and higher currents can be used wherever the work permits. As a result, welding speed can often be increased 15 to 30 per cent.

In addition, a-c welding gives these four extra advantages:

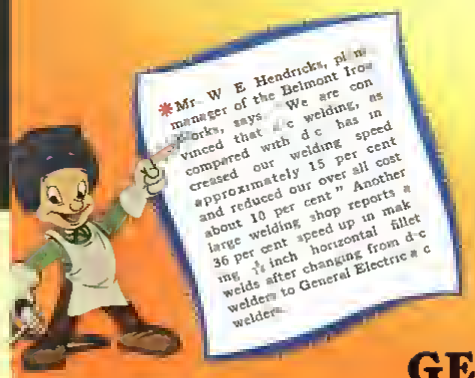
1. ASSURES HIGH-QUALITY WELDS—The molten pool is easily controlled, and the weld is uniformly strong because the operator is not troubled by arc blow. This advantage is particularly apparent when welding in such locations as corners, where magnetic disturbance is usually most troublesome.

2. REDUCES ELECTRODE LOSS—Electrodes larger than 3/16 inch in diameter are furnished in 18 inch lengths. Because a-c welding facilitates the use of these larger electrodes it often reduces stub-end losses as much as 20 per cent.

3. CONSERVES POWER AND CRITICAL MATERIALS. Power consumption is reduced as much as 50 per cent, compared with the power used by d-c welders of the same rating. This is because of the high efficiency of General Electric welding transformers. In addition, only half as much copper and electrical sheet steel is used in their construction.

4. REDUCES MAINTENANCE—General Electric a-c welders have no heavy rotating parts, therefore they require very little attention, other than oiling the fan and the adjusting screw.

GENERAL ELECTRIC A-C WELDERS used exclusively, helped speed up the construction of this huge vacuum tank, one of the largest of its kind ever built. Its fabrication required more than a mile of ¾-inch groove and fillet welds, made with W-26 and W-24 electrodes. Applications such as this all over the country indicate the rapidly growing trend to a-c welding to speed up production and decrease cost.



FOR FIRST-CLASS A-C WELDING *In All Positions*

Use the W-26 Electrode

With this G-E alternating-current electrode you can now do *all-position* a-c welding to meet the following specifications:

A.W.S. Filler Metal Specification E6011

Navy Bureau of Ships, Specification 46E3, Grade III, Class I

A.S.M.E. Boiler Code, Paragraph U68

The W-26 electrode provides a strong, forceful arc and enables operators to make finished welds equal to those made with the best d-c electrodes used for mild steel work.

FOR COMPLETE INFORMATION about General Electric a-c welders, or the W-26 electrode—or for engineering help in increasing the speed and efficiency of your arc-welding operations—simply contact your local G-E arc-welding distributor or G-E office, or write direct to General Electric Company, Schenectady, N. Y.

The Army-Navy "E" for Excellence is the manufacture of war equipment now flies over G-E plants employing 100,000 men and women

GENERAL ELECTRIC

GEA-47-8746

OK for combat

Here you see a Bell Airacobra—world's deadliest single-engined fighter—down from demonstrating its combat fitness.

Cannon and machine guns give the Airacobra devastating fire-power. Baffling maneuverability give its pilots flying edge . . . elusiveness proved by grueling flight tests before an Airacobra is okayed for military use.

For this rugged testing of Airacobras, Bell Aircraft Corporation relies on the safe lubrication given by Sinclair Pennsylvania Motor Oil.

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THESE insidious nonentities raise hob with pilots' nerves, chattering singsong misdirections, playing tag among the instruments, and generally making vicious nuisances of their mysterious selves.

One place they haven't been so successful with their mischief, however, is in the radio instruments, mainly because of Flexible Low-Tension Shielded Conduit that won't permit their sly whisperings and those distracting and interfering static-induced noises to get to the pilot's ears.

With the foolproof protection of Flexible Low-Tension Shielded Conduit, United Nations' flyers hear their radio signals and directions clearly, unfailingly.

American Metal Hose makes a complete line of fittings and accessories for American Flexible Low-Tension Shielded Conduit. Both fittings and conduit conform to A-N, A-C and NAF specifications.

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Centralized Planning For Small Plants

By JOHN H. STEPHENS
Aircraft Products Company

SUBCONTRACTORS SECTION

A successful subcontractor's system gets utmost production from machines, thus helps meet production schedules — a requisite for repeat orders.

WHEN Aircraft Products & Equipment Corp. was founded (see Subcontracting from Scratch, by Eugene K. Grey, AVIATION, Oct 1942) a survey was made among the prime contractors to determine what they wanted most from their vendors. It was found that the prime consideration of subcontracting managers was that of meeting delivery schedules, and the inability to cope with this problem was given as the largest factor on which the major number of subcontractors were failing down.

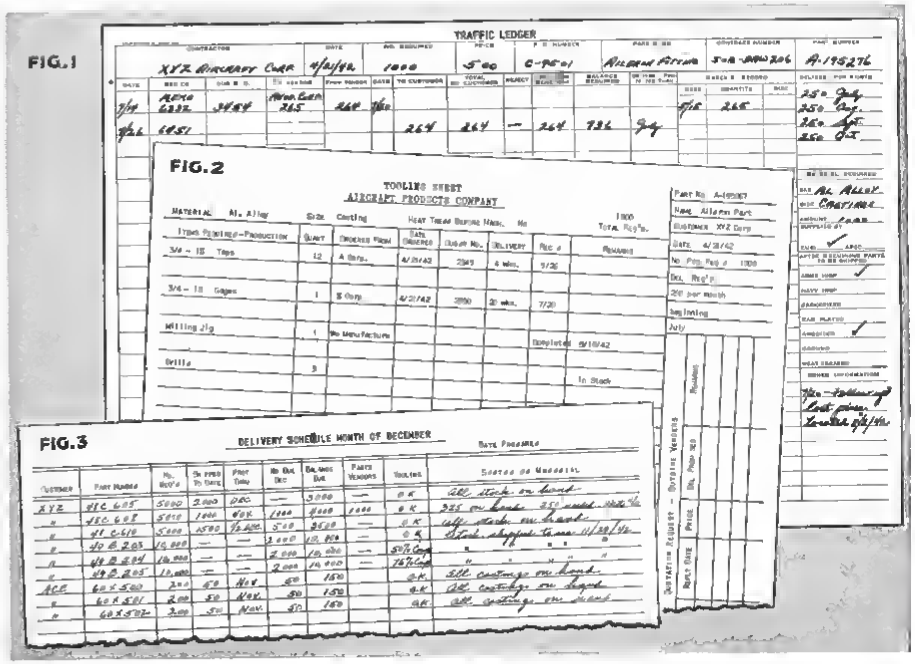
An analysis of this problem will often show that delivery jams are a result of faulty scheduling, rather than of overselling capacity, which is commonly blamed. In some cases it may be a result of over selling a certain machine bank while running out of work on others. A common occurrence is to find the 1½-in. turret lathes all on long runs of ⅝ in bars and the ¾-in lathes idle just when it becomes necessary to make delivery on an order of 1-in bushings.

There are two obvious alternatives, first to break down long runs—a highly uneconomical procedure at best—or, second, to let the delivery slide until a machine is open. Unfortunately for the customer, the latter course is usually chosen for economic reasons.

The centralized planning system outlined in this article has as its main function the utilization of each machine tool as near to 100 percent of capacity as possible by not over-loading to the point where deliveries are jeopardized, but at the same time to avert the possibility of down time due to the ever-recurring problem of material and tool shortages. Thus management must always have information at its finger tips as to machine loadings, customer demands, and when and where each job will be started, in order to meet these conditions, together with the latest data on material expectancies so that down time can be predicted in advance.

Decisions on schedules cannot be left to the foreman, highly competent as

FIG. 1



ba may be from a technical standpoint, for the reason that he is not in possession of all of these facts. The obvious answer is centralized control, which is now becoming necessary even in small plants, if the ever increasing demands of our war efforts are to be met.

A summary of the production control system which has been developed in our company is presented here in the hope that it may aid other small enterprises faced with the same problems. A wealth of material has been published describing systems by which larger industrial organizations can be controlled through highly developed paper systems, teletype dispatching, etc., but the problem as it affects the small plant has apparently been neglected, for it is usually assumed that the small plant manager can keep most of the facts in his head. This, however, requires countless hours of detail work on his part—hours which are now desperately needed in the more important function of controlling policies in an ever-changing industrial picture.

First, to understand the problems faced in a plant of this type, it is necessary to realize the wide variety of work done by it. Aircraft Products Co. (as it is now known) handles a line of general machine products employing screw machines, engine lathes, milling machines, drill presses, bench assembly, etc. Orders may range from a single piece at $500 to 100,000 pieces at $0.01 each, and as high as 150 orders may be in process at any one time.

Obviously no one man or group of men can remember all of the details connected with such varied production. Not only is it necessary for management to have quick access to exact information, but when a customer calls at the plant or telephones from any part of the country, he wants facts quickly and accurately.

It is to meet these requirements that the system here described has been developed. In many cases, expeditors will telephone directly to the traffic clerk in charge of the control system for the information, finding a special trip to the plant unnecessary.

This control system is the result of two years' development and intensive study, during which time various methods were tried and discarded. It is not to be inferred that the final form is by any means perfect, for no system is infallible. However, it has been found to be highly adaptable in solving the problem of production control in the small plant.

To be efficient, any system, must have the following attributes: 1. Quick and accurate information, 2. economy of operation, 3. capability of being operated by relatively inexperienced clerical personnel, and 4. adaptability to sudden expansions in order to handle larger volumes of business. While the system is designed primarily for the small plant, it contains the same characteristics as those in larger industrials and was designed so that it could handle several times the present vol-

Fig. 4. This machine-loading chart gives company's management a complete picture of shop operations for twelve weeks ahead. Vertical ordinate at left of chart gives code numbers for various machines in shop, while horizontal ordinate at top gives dates in calendar weeks. Cards, hung on pegs on board, give number of each job on which machine will be occupied.

uns of business without serious readjustment. It is sufficiently mechanical so that capable but inexperienced women clerks can be taught to handle the routine within a short time, a feature of vital importance, since it is becoming necessary for women to take over positions formerly held by men.

While the description given below is in considerable detail, the simplicity and economy of the set-up is reflected in the fact that the total cost of operation is less than 1 percent of the gross sales. This cost has been repaid many times over in repeat business through customer goodwill and in releasing management to perform the duties commonly associated with their function.

The system comprises four units. The traffic ledger, tooling sheet, delivery schedule, and loading chart. A description of each and its function in the process is followed by an example in which a hypothetical order is handled from beginning to end.

The entire system of control is built around the traffic ledger (Fig. 1), which is not only the starting point for the process of carrying an order through the plant, but also the final word at any moment on the status of all jobs. It is used as a constant reference not only by management and the clerical force, but by the customer.

As each new order comes in, a traffic ledger sheet is made out and placed in a loose leaf binder. When the last shipment is made completing the order, the sheet is removed to the dead file. The ledger is handled entirely by the traffic clerk.

This form contains the following data in one place:

1. Pertinent information from the customer's purchase order, such as part number, name, purchase order number, price, number on order, and date.
2. Schedule of delivery requirements.
3. Material requirements.
4. Finished parts disposition, such as outside processing and inspection.
5. Material receipts.
6. Shipments and receipts to and from vendors.
7. Shipments to customers.

Containing the above information, the traffic ledger performs the following functions:

1. It provides both management and the customer with the entire status of the order (except for work-in process) at any moment. In many cases the expeditor will call the traffic clerk directly for information on the job as this ledger answers his questions of how many units have been shipped, when they went to the vendor for plating, etc., and what shipments are in transit of which he has no record. There is also data on raw materials.

2. It provides a central clearing house within the plant for all details of traffic without loading management with countless routine questions, such as, "How much material should be purchased? Is the material that has been received the correct size, quantity, and analysis for the job? Are the parts to be anodized or cadmium plated? Are the parts to be government inspected?" With this latter provision, the traffic clerk may automatically call the appropriate government inspector when parts are ready for shipment.

3. A weekly review of the ledger enables the traffic clerk automatically to expedite raw material and parts at vendors to meet delivery commitments. Only in unusual cases is it necessary for management to do outside expediting, as the traffic clerk has this information before her and is responsible for knowing where the material is and when it will be finished.

4. The traffic ledger forms the basis for making up the shop and delivery schedule, which is explained later.

The tooling sheet (Fig. 2) is used by the engineer in tooling the job and is kept permanently in his files, along with a copy of the blueprint. Noted thereon is the complete tooling record, including not only tools to be manufactured in our own shop but also special gages, tools, etc., purchased outside, also the purchase order number and promised delivery dates.

Main function of the tooling sheet is to provide a ready reference for this information and to indicate at all times what remains to be done in the way of tooling before a job can be run. It is also used as a check list to expedite outside tooling which may be holding up a job.

Main function of the delivery schedule is to lay before management the coming month's work in the shop; it is the medium for *monthly* production control. As shown in Fig. 3, the sheet is a one-line summary of the status of all parts on unfilled orders taken from the traffic ledger. Columns are provided for the quantity on order, number of pieces shipped through the first of the month, delivery projected through a given month, number due during the current month, and material status.

On the first of every month this sheet is made up by the traffic clerk from the traffic ledger sheets and is placed on the management's desk—for the first thing in which management is interested is the current month's commitments. A copy is sent to the factory superintendent in the form of a memo which is, in effect, his orders for the coming month.

The delivery schedule also shows where material will hold up deliveries on jobs, thus customers can be notified of this fact. At the same time it also shows any straggling items, such as orders with only a few pieces yet to be shipped which might have been overlooked in the shop. Once a month these

parts are cleaned up, regardless of whether they are done or not.

As its final function, this form cares for the revision of the loading chart, which is explained in the next section.

In order to determine sales policies, as well as general production policies such as machine tool requirements and personnel force, it is necessary for management to have before it at all times a complete picture of shop operations for a considerable period ahead.

Medium for handling this is the loading chart, shown in the accompanying photograph (Fig. 4) which is a visual machine loading diagram hung on the office wall. The vertical ordinate (at left of chart) indicates in code the various machines in the shop. The horizontal ordinate (top) gives the dates in calendar weeks. Experience has shown that material and tooling considerations make twelve weeks the practical limit for such a chart. It has also been found that it is necessary to schedule only main machine tools, as drill press and bench hands can be determined by a ratio to machine operators.

Punched cards are bought in long strips, cut to the job's duration, and hung on hooks on the chart. Every two weeks the calendar cards at the top are moved to the left and the board revised to accommodate changing conditions. A red crayon line under the part number on the card is a visual code indicating that material is in the house. A quick glance at the board thus furnishes management with the following guides:

1. Reading to the right, the capacity loading on each machine for twelve weeks is shown. This determines sales policies as to when to accept additional orders. It shows capacity that has been committed for which there is no material. It indicates when production will be interrupted because of material shortages. When a customer telephones long distance, capacity can be quoted quickly and accurately by a glance at the chart.

2. Reading vertically, the man loading for any week can be determined. It has been found through experience that the ratio between machine operators and bench hands is approximately three to one. The figures thus derived determine the hiring policies for the period.

Here, as a typical example, is a hypothetical job from the time the customer's purchase order is received until the finished parts are delivered to the prime contractor:

The XYZ Aircraft Corp. orders 1,000 aileron fittings at $5 each for delivery of 250 pieces per month beginning in July. The corporation is to furnish castings.

When the purchase order is received in the Aircraft Products office, it is first sent to the traffic clerk who records the main information on the top line of the traffic ledger sheet, as shown in Fig. 1. Recorded in the upper right hand corner are, first, the delivery requirements, then immediately below, the material requirements, and below this the final disposition of the parts.

At the same time that the traffic ledger is made up, the pertinent information is recorded in brief by the traffic clerk on the tooling sheet, Fig. 2. The tooling sheet, together with the blueprint, is then sent to the engineer's desk for tooling purposes. The purchase order is filed in the active customers' drawer where, from now on, it is used only as a reference, since all necessary data is on the master forms.

From the blueprint, the engineer plans the tooling of the job. Special taps and gages not carried in stock are needed for this hypothetical order, together with a milling jig. Taps and gages are ordered on our purchase order Nos. 2349 and 2350. The milling jig is designed and drawings sent to the shop for fabrication. The best delivery which can be secured on gages is 20 weeks, so the customer is notified they will be received too late to make his delivery on July 30. Therefore a higher priority rating is requested.

Any time the customer wishes to know the status of special tooling on his job, the tooling sheet tells the whole story. Through expediting, the gages are received on July 20, in time to make delivery.

On May 15, 265 castings are received from the customer and this fact is recorded on the traffic ledger in the material record blank. On July 14, machining is completed and the stock clerk, calling the office, is advised by the traffic clerk that parts are to be sent to Anodizing Corp. for processing. An entry is now made from the packing slip No. 6332, and purchase order No. 3454 is made up for the vendor.

On July 22, 264 pieces are received from the vendor and the appropriate entry is made showing the loss in transit of one piece, which is then followed up by the traffic clerk. The shipping clerk then calls the traffic clerk for orders on disposition of material and is told to hold for Army inspection, whereupon the traffic clerk arranges for the inspector to call at the plant. On July 26, the parts are inspected and as the traffic clerk makes up the packing slip and invoice at one time, the appropriate entry being made in the traffic ledger. The packing slip and invoice carry the same serial number for convenience in follow-up.

It can now be seen that the company is protected on deliveries through July, but since no more material has been received, the customer must be notified that it will be impossible to meet August obligations unless castings can be shipped immediately.

It is now the first of the month, so when the traffic clerk makes up the delivery schedule, she records the summary of this information as shown in Fig. 3 along with all other jobs in the plant. From the delivery schedule, the engineer will then plan production of his part for the next three months.

Since the delivery schedule shows the status of the part, and knowing approximate hours on the milling machine and lathe required to machine it, the following facts become self evident. To meet scheduled deliveries, we must reserve one week's time on a milling machine and two weeks' time on a lathe during each of the remaining three months, and since the parts must be sent out to be anodized, this time must be reserved near the beginning of each month. The appropriate cards are hung on the loading chart, and the part then takes its place in the future operations of the shop.

Men and Machines Available for War Work

Production facilities—plants, precision tools, and skilled operators—are available in further the war effort. To bring prime and subcontractors together, AVIATION offers this clearing-house of information. Address inquiries, with reference to accompanying key number, to AVIATION, 330 W. 42nd St., New York.

Magnesium Work.....S-141

Leading magnesium producer and fabricator seeks "co-prime contractors" in magnesium fabrication work to meet required schedules. Rather than offering straight subcontracting, this organization is endeavoring to enlarge productive capacity by bringing into the field companies which, it is realized, will first need instruction and benefit of its experience of methods of fabrication of this material. The company plans to work with suitable fabricators by supplying them with as much technical and operating information as possible until the newer groups have familiarized themselves sufficiently to be able to handle jobs directly.

Equipment requirements are rather extensive, but it is not absolutely essential that all the types required be available from any one single organization. General equipment requirements include the following.

1. Presses. Mechanical presses—double action, single or double crank drawing presses. Toggle presses may also be used. 50-150 tons on main ram, 50-100 tons clamp pressure. Sheet height 24 in., stroke, 12-15 in. Minimum bed area, 30 in. square, but 3x4 ft. bed preferred. Hydraulic presses—should be double or triple acting type with approximately same or slightly greater dimensions than mechanical presses. In second action of press, between 25 and 100 tons is required for holding pressures to cover majority of the drawn parts.

2. Mechanical presses of straight single action type of 25-50 tons should be available for blanking operations.

3. Shears—Any close tolerance type can be used, and a 6-8 ft. bed should cover any type part in general fabrication work.

4. Press brakes—Any standard high quality type may be used, dimensions similar to shear beds.

5. Routers—Any standard high speed machine may be used, with 10,000-20,000 rpm. on the router tool recommended.

6. Forming rolls—Any standard type sheet metal forming rolls may be used, with about 6 ft. rolls recommended.

7. Welding equipment—General welding equipment should be available, aluminum equipment if possible.

8. General machine tools—Lathes with about 4 ft. beds and 8 in. swings; portable (electric or air driven) drills, buffers, and sanders.

9. Heating—Gas facilities should be available for connecting with small portable, box type ovens.

Electric Plant Facilities....S-142

Pennsylvania shop, normally engaged in manufacture of electrical wiring devices, employing several hundred skilled workers, and with backlog of over 20 yrs. experience, seeks machining, stamping, rubber, and plastic molding work. Equipment includes: Two Cleveland single spindle automatic screw machines, one with 2 in. capacity, other 3½-in. capacity with 6-hole turret, 19 production Lincoln type No. 2 milling machines; eight 22-in. swing 6-hole turret geared chucking lathes; five hand screw machines, ⅜- to 1¼-in. capacity, five engine lathes, 9-24 in., a high speed bench lathe, ½ in. capacity, 10 drill presses, ½-in. capacity, one of 2-in. capacity; a Bickford heavy duty radial drill, 3-ft. swing, a No. 2 Brown & Sharp automatic surface grinder, a Gisholt turret lathe 1¼-in. bar stock 14-in. swing for chucking; a Hartford ¾ in. capacity automatic screw machine; a 24x24x6-in. Gray planer; an R. A. Kelly 16-in. shaper, a Doall band filer, a Doall S-14 band saw; a Rickert-Shafer 5-80, ⅝-in. capacity horizontal tapper, and an Oliver bench die filing machine. Rubber molding equipment includes 12 hydraulic molding presses, two mixing mills, a calender, tubing machine, and open vulcanizer. Stamping equipment includes 17 power punch presses ranging from 1-2½ in. stroke, maximum draw 1½-in. deep, 6-in. dia. disk from 0.092 stock. Plastic molding equipment is listed as 14 F. J. Stokes and Cropp automatic molding machines for thermosetting plastics and complete plastic finishing department equipped with belt sanders. Other equipment includes lacquer spray booths, baking ovens, nickel and copper electroplating, small assembly work tools, die, tool, and mold building and maintenance equipment.

Has Shop Facilities.....S-143

Company in Minnesota, which has had 25 years in electrical construction field, is prepared to take part-time work now and full-time work later. Shop, 20x30 ft. and 1½ stories, is located on five acres adjoining main highway, has railroad facilities in rear, and is three miles from a leading airport. Following equipment is listed: 10-in. circular saw, tenoner complete, moulding head and cutters, 6 in. dado head of 13/16 in. capacity, mortiser of ½-in. capacity, 6-in. jointer, wood shaper with 5/16 and ½-in. spindles, 24-in. multi-speed scroll saw, 14-in. woodworking band saw, wood lathe with 12 in. swing and 37-in. center and tools, also erecting and assembling hand tools. Plant can handle small steel and copper bus bar fabrication.

first

in advertising page gains over all U. S. monthly publications *without exception**

*The record — *Aviation* gained 953 pages of advertising in 1942 over 1941, the largest page gain of any U. S. monthly publication biggest by far of any aeronautical magazine Total pages in *Aviation* in 42—2585—*excluding classified* Number 1 among *all* publications was the weekly *Iron Age* with a 1279 page gain followed closely by McGraw-Hill's bi-weekly *American Machinist* with 1188 pages gained *Aviation* was 3d in page gains for the year among *all* publications weekly bi-weekly monthly—consumer or industrial. (Figures quoted from *Industrial Marketing.*)

Nor in a spirit of boastfulness do we headline that statement. But rather to underline (1) the tremendously increased importance of the aviation market to the business men of America, and (2) the essential part the magazine *Aviation* plays in that market.

This year the aviation industry will spend nearly nine billion dollars ($9,000,000,000), more than the estimated new revenue of the recently enacted Federal Income Tax. All but a negligible amount of this huge sum of money will be spent by the very type of men who read *Aviation* — the executives who hold the yes-or-no key to purchasing decisions in aviation's manufacturing, operating and maintenance divisions, and that important group of government and military officials concerned with aviation.

Aviation is edited for, and read by, the serious-minded men of the industry . . . the men whose interests are the technological advancement of aeronautics, the betterment of operating and maintenance practises, the realization and continuance of America's supremacy in the air.

The influential names of the industry do not number in the millions. They can be counted in a few thousands. Thus *Aviation* does not spread its circulation over the pyramiding millions of non buyers. *Aviation* concentrates its circulation effort on the top segments of each of the industry's branches, covers the buying power you reach for in your advertising.

Example: A recent letter-survey (mailed over an independent list) to top aeronautical manufacturing executives disclosed that better than 3 of every 4 not only read *Aviation* regularly, but found it of practical use in their daily work. The letter went only to the highest ranking men in representative aircraft, engine and propeller plants — presidents, general managers, engineering heads, design chiefs, production managers, purchasing agents, etc. . . . *no one below the rank of department head.*

Aviation advertisers realize the dominant influence of this group of men. As a result you'll find among the 577 manufacturers who advertised in *Aviation* last year practically every important builder of airframes, engines, propellers, instruments, accessories, materials and parts.

A NEW BOOK TO AID YOUR MARKET PLANNING is now available without cost to interested sales and advertising executives.

A factual, informative and unusually comprehensive study of the aviation market today, and tomorrow. A guide to the important buying influences to consider in your selling and an invaluable help in measuring the sales possibilities for your product in this huge and expanding market. Plus complete editorial, circulation and advertising information on *Aviation*, to help you plan a thorough-coverage advertising program. A request on your business letterhead will bring your copy of this book promptly. Address *Aviation*, Market Research Division.

The oldest American aeronautical magazine

AVIATION

A McGraw-Hill Publication
330 West 42d St., New York, N. Y.

AVIATION — INFORMATION HEADQUARTERS FOR THE MEN WHO DESIGN, ENGINEER, PRODUCE, OPERATE AND MAINTAIN AMERICA'S AIR SUPREMACY

AN AIRCRAFT FACTORY FOREMAN, desperately seeking a foundry worker for the swing shift, found a woman among the applicants. Politely, but firmly, he rejected her. Later, as the hunt proved fruitless, he reconsidered the woman. Even so, he painted a thoroughly black picture of the foundry, said the job was being offered against his better judgment. His misgivings weren't stilled by the applicant's quiet assurance that she could do the job and take care of herself.

Couple of weeks later the phone shattered his slumbers about 5 a.m. "You the guy who hired a woman for the foundry?" an excited voice shouted. His affirmative answer brought a demand to "come down here quick and straighten out the trouble you've caused."

Reaching the plant in the pre-dawn cold, he found the feminine staff member serenely going about her work—but one of the male members had been taken to a hospital. Seems he'd made a pass—and suddenly found himself tossed clear across the room, unable to get back on his feet.

Now that he's back from ten days' sick leave—with the knowledge that his co-worker is one of the country's outstanding feminine jiu jitsu experts—production has returned to normal.

Everyone seems to be minding his own business.

• THE OTHER DAY we read about a New York elevated train getting on the wrong track, ending up stalled in a subway and raising hell with the city's transport system. One newspaper blamed the Gremlins, but we say faint so.

No Gremlin, self respecting or otherwise, would have any truck with such mundane things as trains—elevated, surface, or subway. We say this on the basis of long experience with Plastards which, with the Brooklyn Brothers, were more or less legitimate progenitors of Gremlins.

• YEARS AGO a friend was teaching us to fly in an OX-5 Eaglerock, for which we had no hangar—old faithful just sat out under a southern Arizona sun. Sometimes, as we stuttered to untie her, we'd hear strange rustlings within the wings. Never investigated, because we didn't want to know what condition the ribs and spars were in.

But the man who bought the ship investigated when he started to do a recovering job. He swears—with witnesses to back him up—that one wing contained a field mouse nest and that from the spar of the other, a vine was growing. What, we ask, but a Plastard or its English offspring, the Gremlin, would lead a field mouse to such a location, to take the trouble to water a vine taking root in a spar?

Can tell us anything with that kind of sense of humor would mess around with elevated trains.

• "TAKE A LESSON FROM THE AVIATOR" says an advice-to-the lovelorn column. "If he has a crack-up, he must go aloft again with a new plane before he quits the field. When you are jilted or made unhappy regarding one member of the opposite sex, don't take the cowardly attitude of cynicism. Get a new date the very next night!" Imitate the aviator, for his procedure is sound psychology. Besides, you cannot be vitally conscious of two men at the same moment."

Look, ehmm let's leave sex out of aviation—we got trouble enough as it is.

• FINAL PROOF the Nazis just can't win comes from Fatso Goering himself. Remember when the RAF delivered his "celebration" speech by a daylight raid right on Berlin? With a whole hour in the air raid shelter to think up a good ad lib, he could do no better than plow through the speech Jo Goebbels had written for him. You'd nearly catch FDR or Churchill using answer with that much tone. But then you'd never catch them as far out on a limb as Fatso has left himself.

SIDE SLIPS

I'll bet you the five bucks profit you have left, Maguire—that now you're in favor of pay-as-you-go!

This Year Rubber Is Tapped from Test Tubes

Synthetic Rubber Already Is Working for Users of Mechanical Rubber Goods

War production is up threefold But the vital rubber stock pile is dwindling fast. This is the year of crisis in rubber.

There is only one solution . . . the production of synthetic rubber in steadily increasing tonnages . . . synthetic rubber to take over jobs once handled by natural rubber . . . to perform new tasks, serve in new applications created by wartime need.

One of the first synthetic rubber plants in the Government's program was built and is being operated by United States Rubber Company . . . another soon will be in production.

Our engineers have been working with synthetic rubber since 1921 During this period they have learned that no one synthetic should be used for all types of mechanical rubber goods. They have found where and how synthetic is superior to natural rubber, where it is equally as good, where it falls short. They know what uses each of the five basic commercial types of synthetic rubber is best suited for — Neoprene, Buna-S, Buna-N, Butyl, or Thiokol—and how to compound the specific synthetic rubber for the specific task. U. S. Rubber has used all five types and knows which one to select for the performance required.

Information based on the results of vast experiments and practical applications of synthetic rubber has been incorporated in a new comprehensive book, *The Five Commercial Types of Synthetic Rubber*.

This informative book traces the history of synthetic rubber from the earliest experiments of Michael Faraday to the present. It discusses each of the basic types of synthetic rubber, tells where it has been used successfully in United States Rubber Company products, and compares its properties with natural rubber. It tells how synthetic rubber is made. It is a detailed answer to the most vital question of the day.

We feel that *The Five Commercial Types of Synthetic Rubber* is a publication of real importance to men of industry. Requests made by them on their company letterhead will be filled promptly.*

The successful use of synthetic rubber in mechanical rubber goods and the insurance of fully dependable service depend largely upon the skill of the manufacturer and compounder. Each of the five basic commercial types of synthetic permits a myriad of variations.

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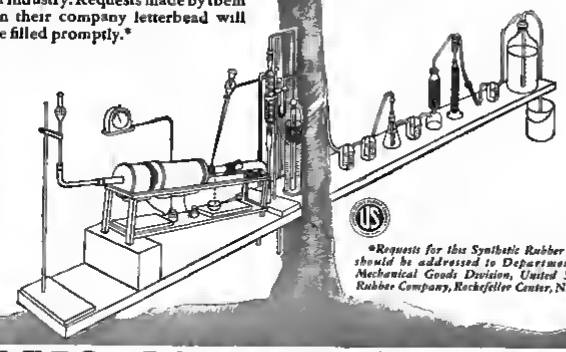

*Requests for this Synthetic Rubber Book should be addressed to Department 1 Mechanical Goods Division, United States Rubber Company, Rockefeller Center, N. Y. C.

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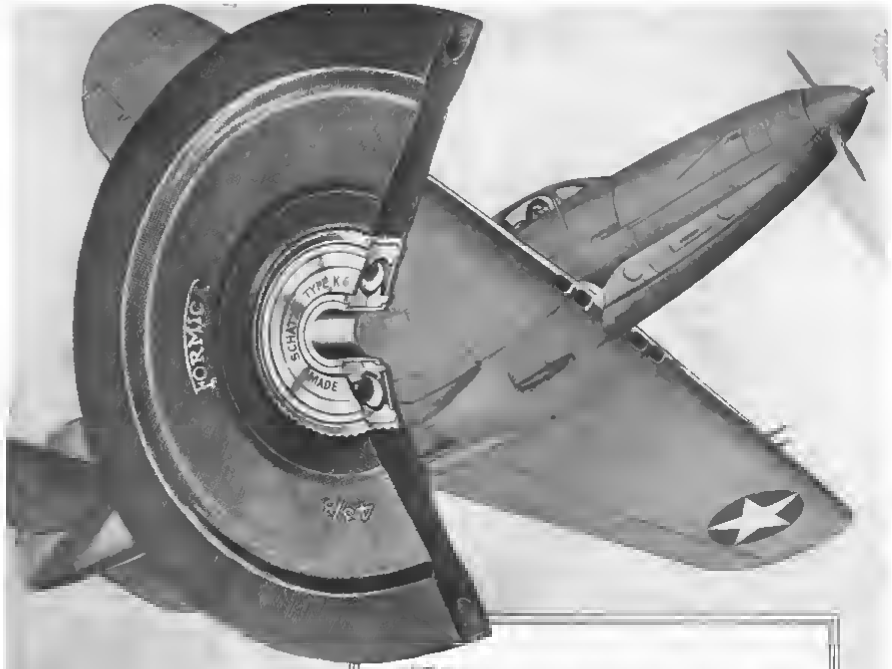

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GROUND TIME . . . Spells Profit or Loss

By WILLIAM A. LIPPMAN, JR.
Former Manager of Freight & Express Western Air-Lines

Vital time problems are posed in the air freight field which can "make or break" the postwar operator. True, "boxes can't argue" —but profit or loss, says this expert, hinges on how they are handled.

HAVE YOU EVER STOOD on one foot and then the other, muttering imprecations while an airline crew loaded express and mail for "delayed departure" of a plane you had just broken your neck to catch? Most of us have, in these days of overtaxed transportation. And were you an official of that particular line, with an eagle eye on costs, you would be wincing inwardly every time it occurred.

For you would know that an airplane earns not a copper penny sitting on the ground, unless it is a movie "prop." And since that plane represents the major source of income for a common air carrier, either passenger or cargo, then every minute it spends on the ground is an entry on the wrong side of the ledger.

Veteran shipping men aptly phrase one reason for them preferring the inanimate side of transportation—"Boxes can't argue with you." And it is likewise true that boxes cannot walk up and down a freight dock and swear at delays. But even seemingly that box rests quietly at some airport, while cargo handlers trundle loads on or off, takes a chunk out of the revenue paid in by the shipper.

Piles of statistics have been compiled in search of a ton-mile cost yardstick from which to project competitive tariffs for airborne freight. It is easy to ascertain direct and indirect flying costs. Ground pickup and delivery costs and general overhead expense will run at a fairly well defined ratio to the volume of business handled. However, when the chips are in, the operator who keeps his planes *in the air* for the greatest number of hours out of each 24 will be the man who rakes in the pot. That one item is the most important variable in the commercial air freight pattern.

Ground time can be divided into three major categories: (1) Maintenance; (2) Between-schedule layovers, or turnarounds; and (3) Stops enroute. Since unscheduled delays due to weather or equipment breakdown cannot be anticipated, they are disregarded in this discussion.

Of these three, maintenance time is the least flexible. Even though planes used exclusively for domestic cargo may carry fewer instruments and be generally of rugged, more simple design, the steady abuse of heavy loads and the desire to maintain high safety standards of equipment will call for an ample minimum of service time.

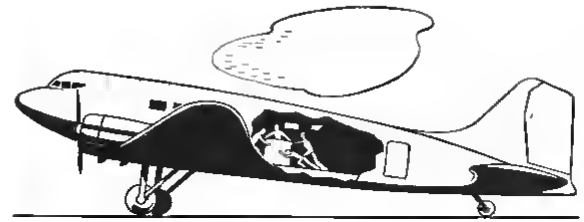
The necessity for scheduling passenger plane departures to the tune of the traveling public's desires has been a constant headache to operations executives. Planes land in hangars for many hours after night crews have checked the last control cable and brushed off the last armchair, awaiting an early morning departure. Recalling that boxes neither talk nor walk, we also realize that they do not sleep or eat. Freight schedules can be arranged to suit ourselves and our equipment, and planes can depart at any hour of the night or day. This will add countless hours to utilization of equipment and dollars to the income account.

It is axiomatic in the shipping business that despite all attempts to achieve a balance, the bulk of shipments is delivered to carriers in the late afternoon and evening hours. This concentration of activity is especially prevalent in peacetime when but a small proportion of plants work around the clock. It will be advantageous to air freight operators, particularly transcontinental carriers, enabling them to schedule departures for any convenient hour of the night to reach major terminals in time for early morning delivery to consignees.

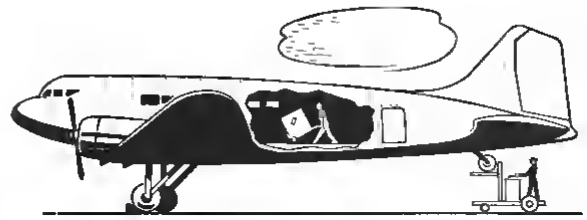
Passenger planes loaf around hangars, awaiting early morning departures.

Short haul carriers can make several round trips in the same night and lay over for maintenance work during the quieter forenoon period. They can, that is, if in quickly turning their plane around and returning it fully loaded, they can overcome the major problem confronting any carrier at intermediate points, namely, loading and unloading time.

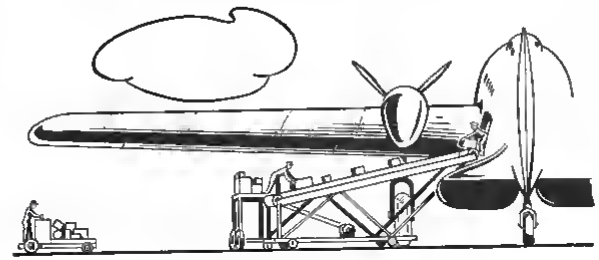
A transcontinental freight plane hauling through loads between New York and San Francisco and stopping only for gas and crew changes enroute can deliver goods at the lowest possible cost of operation for the equipment used. Slow loading and lashing could be offset in this case by superimposing the time necessary



Manhandling 500-lb. boxes up hill.



For a level deck, the tail must be raised by some convenient means



Belt loaders are definite time savers.

upon that allotted for maintenance, permitting them to be done simultaneously. It wouldn't create a very happy working condition but it could be done.

According to the Railway Express Agency a breakdown of Air Express Division shipments for a recent peacetime period disclosed that 15.8 percent was hauled distances under 350 mi., 18.0 percent between 350 and 650 and 24.2 percent between 650 and 950 mi. In excess of 580 percent, therefore, moved less than 1,000 mi.

The Illinois Central system in a recent survey found that the average haul of rail express—the classification widely believed most vulnerable to air freight competition—was 487.5 mi. for a similar period. It would seem likely from these figures that future air cargo hauls will average in the 500-700 mi. bracket, which will demand multiple short haul service coupled with transcontinental haul trips making numerous enroute stops.

An air freight schedule recently used by the contract airlines, with converted Douglas ships operated by commercial pilots, was set up to make 14 stops between Los Angeles and New York City. Terminal to terminal elapsed time of 14 hr. 20 min. included 7 hr. allowance for the intermediate ground stops, or 28 percent. Looked at another way, the 40 min. stops consumed 40 percent as much time as was needed to fly the route. It is not unusual for freight planes to spend 1½ to 2 hr. at a station while two or more tons are unloaded and new cargo placed aboard, and 4- to 6-hr. stops are not unheard of.

Aside from the uneconomic aspect of such an operation on a long haul, consider its effect upon a nonstop short haul "merry-go-round" of 400 mi. Round trip flight time would be 4 hr. 40 min. Add 45 min. for original loading, 90 min. at the turnaround point and 45 min. to unload the return cargo, a total of 3 hr. This is 37 percent of the overall time and 64 percent as much ground time as flying time.

Note the probable cost in dollars of having equipment spend one third of its earning time on the ground in this manner. A Douglas C-47 two engine cargo plane hauling an average pay-

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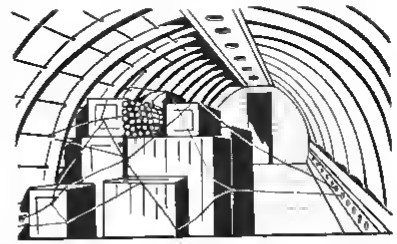

Typical loads have a gigantic web woven over them.

AIR TRANSPORT

American Airlines' Materials Laboratory Gets Paying Results

Fig. 1. Mixing tank, with G K Brower observing and V Thronson about to add treated earth to used oil

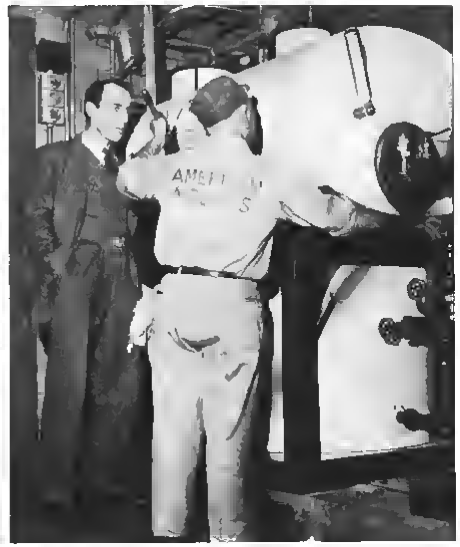

Fig. 2. Heating and steam stripping in retort. Temperatures run from 475 to 625 deg. F. Steam agitation prevents any great degree of cracking or polymerization around heating units and with vacuum, takes off any undesirable vapors formed

Oil saving up to 25 percent of purchased total and reclaim of 98 percent of cleaning solvent are only two of the many transport problems profitably solved by this department of American Airlines, with a wide range of other accomplishments in its history.

DURING ITS TWELVE YEARS of operation, the American Airlines Materials Laboratory under Chief Engr Kirchner and Materials Engr Brower has covered an extremely wide range of testing and research activity. The first four years were devoted chiefly to spot tests on samples and lots of materials and supplies and routine tests on used oil to determine oil change periods. Since that time it has conducted research on all the problems which confront transport aviation. The following list illustrates a few of the projects treated by Mr Brower at N Y:

Carbon monoxide in cabins and cockpits
Windshield de-icing
Anti-freeze solutions
Carbon tetrachloride vs. CO_2 in fire extinguishers
Fumigation rooms, dry cleaning units
Quarantine regulations, insecticides
Corrosion difficulties
Standardization of aircraft brushes
Identification of aluminum alloys
Identification color codes of lines
Water conditioning heater and drinking
New hydraulic fluids
Aromatic petroleums—their action on rubber and synthetic lines
Re-refining oil
Re-distillation of cleaning fluid

Although the details of treatment vary with the subject there is a rather characteristic framework of procedure. First, a precise statement of the problem and the reasons back of it, followed by consideration of materials and processes, with compilations of previous work by firms connected with the problem, test data, cost data, comparative data relative to former recommendations, and conclusions.

The work is of potential importance to the whole aviation industry. Mr Brower is closely connected with the Cooperative Research Council, whose organization promises much in the direction of interchange of ideas between all transportation groups.

Of particular interest in the national conservation picture are the results obtained from the Laboratory's Refinol process, which is not to be confused with oil reclaiming, but is a complete

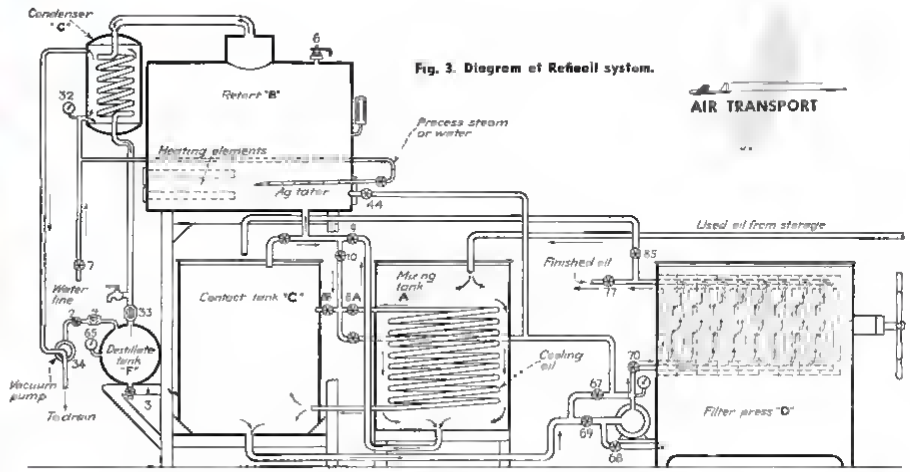

Fig. 3. Diagram of Refineil system.

re-refining system applicable to any maintenance base where regular engine oil change is carried out.

The percentage of oil saving out of total oil purchased may run from 10 to 25 percent. In normal transport operations, as carried on during the last four years by American, a saving of 25 percent can be maintained, with calculation based on the following factors: Operating twin motored equipment, with oil changes at 100 hr., with 90 percent of the oil changes being made at a major base, and considering oil consumption at one half gallon per hour per engine. For example, if total oil purchased amounted to 500,000 gal., the amount consumed would be about 350,000 gal. With 150,000 gal. drained, and a 90 percent recovery which the equipment maintains, a saving of 135,000 gal. would be effected.

Operation of this process is as follows: The used oil (see Fig. 3) is mixed with an activated earth in a mixing tank "A" and then drawn by vacuum into an electrically heated still or retort "B" where it is raised, under controlled vacuum and steam stripping, to a sufficiently high temperature to strip off dilution and moisture, and maintained at such temperature long enough to insure proper clay contact. After this the heat and vacuum are turned off and the oil and earth allowed to flow by gravity through coils to the mixing tank, which act as heat exchangers, cooling the heated mixture and pre-heating the next batch of used oil in the mixing tank "A". From the coils it flows into contact tank "C" where a filter aid is added. It is then pumped through a plate and frame type filter press "D" with the filter cloths precoated and backed up by a paper filtering medium. The vapors are drawn from the retort by vacuum through a condenser "E" to a run-down or distillate tank "F".

The vacuum used in the process is produced by passing the water which has acted as coolant for the condenser through an inverted type steam jet. Any type of filtering earth may be used in the contact treatment, such as Fuller's earth. But two types of activated earth used by American—Magnesol and Retrol—can be used in smaller amounts. For a filter aid, J-M Hyflo Super Cel or a similar product made by the Dicalite Co. may be used. Temperatures in the retort should not be dictated, since this depends on the oil being refined, type of earth used, and combination of chemicals. The average at American seems to be about 525 deg. F. Figs. 1 and 2 show mixing and heating, respectively.

Capacity of this machine is 250 gal. per eight hour day, run in two shifts, 500 gal. Total cost of process with all expenses figured in is .095c per gallon. Quality of the re-refined oil is in every way equal to new oil. Various processes in use in the past led to discredit of such attempts, but every standard test applied to new oils have been run on these re-refined oils, including Sinclair's Bus Engine Sludging Tests, and in direct comparison the results have been equal. In use at American for some years, they have used over 5,000 gal. per month of re-refined oil in their engines during 1940. It is generally used in varying mixtures with new oil.

Another salvage operation conducted by the laboratory is the re-distilling of cleaning fluid, done in an ordinary vapor-condenser still, as shown in Fig. 4. Filtering this solvent is of no avail since all sediment and foreign matter may be removed and still leave 25 percent oil or grease in solution. Re-distillation returns the solvent as clean as new in storage tanks. Percentage of recovery by volume has no meaning here, since there may be only 10 percent of solvent to 90 of water and oil, but of all solvent present, 97 to 98 percent is recovered.

Fig. 4. Still for reclaiming cleaning solvent which recovers 97 to 98 percent of solvent present in solution distilled.

Many of the items listed at the beginning were dealt with some time ago.

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Regulatory Stability For Air Transport Industry

By H. L. FEDERMAN

A series of recent mail rate decisions by the Civil Aeronautics Board will not only have a major effect upon the revenues of the carriers involved but represent significant developments in the regulation of the industry.

CAB has moved with dispatch. In a period of less than three months—and up to this writing—action has been taken on no less than twelve separate air carriers. The indications are that mail rate decisions on the remaining airlines will not be long in forthcoming. Incidentally, in the interim, the board has also found time to act on two major route extensions.

The first of these series of rate decisions established the pattern for subsequent actions. The Eastern Air Lines decision, publicly released in May 1942, settled many controversial issues and now appears to have provided the framework for the determinations that followed in the other cases shortly thereafter. Introduced for the first time was the "service" rate of 3 mill per lb/mi for the transportation of mail. This same rate was established as the future mail compensation for every carrier except Colonial Airlines.

Earnings Recapture "Out"

On the heels of the Eastern decision came the American Airlines action which decisively settled the question of retroactive recapture of earnings. However, this course was foreshadowed by the board's decision in the Pan American-Grace Airways case many months earlier. From all appearances, the air carriers are no longer in any jeopardy of having past earnings recaptured by board action. However, the airlines may anticipate subsequent adjustments from the time the board officially serves notice that rates are to be under review.

In the American, Eastern, and all subsequent cases, the majority opinion of the board appears to have disavowed any intention to establish a rate of mail compensation so as to limit earnings to a fixed rate of return on the investment. For example, under the new mail rates, Eastern and American are estimated to be earning between approximately 30 and 35 percent on their total investment, after all taxes and charges. This is a decided contrast to the 10 percent limitation which was a definite part of the earlier decisions in the American and Panagra mail rate cases.

The board has taken a significant step forward in defining its approach towards arriving at a proper investment base. In the American case, the board declared:

"... In exercising its rate making functions (the board) has never and does not now measure the reasonableness of the rate in terms of a fair return upon the so-called fair value of the property used and useful in the public service. One of the primary factors which is frequently controlling, in determining the fair value of such property is its reproduction cost less depreciation. We believe that experience has proved such method to be administratively and economically unsound, its application to public regulated enterprise during the past four decades has placed upon state and federal regulatory agencies a burdensome, complex, expensive, and futile task. We believe that the ascertainment of the capital cost of producing the air transportation service requires that the rate of return should be predicated upon the funds which have been actually and legitimately invested in the transportation enterprise rather than upon any valuation of the carrier's property, and we shall continue to adhere to this method in the future as we have in the past. Accordingly, we regard reproduction cost as relevant and immaterial to the issue of a fair and reasonable rate and evidence of this type in the future will not be admitted to the record in rate proceedings for the purpose of showing the value of the carrier's property."

This statement is a clear-cut declaration and may be taken as a sound guide in all future determinations as to what constitutes value in the property accounts of the carriers. This is important, since the investment base will long remain as a major factor in all subsequent rate cases.

In all of these rate cases, a member of the board, Mr. Branch, has strongly dissented on the question of mail compensation established for the carriers. In the Eastern case Mr. Branch sets forth his objections as being twofold. First, he holds that the rate of return on the investment under the new rates will be too high and unjustifiable. Second, in allowing such an excessive rate of profit on the carrier's mail operations, he contends that a government subsidy is provided for a carrier no longer in the subsidy class. This minority view is re-echoed in the American case and in subsequent decisions.

The 3 mill per lb/mi rate for the transportation of mail was extended through 'show cause' orders for National, Braniff, Chicago & Southern, Delta, Transcontinental & Western Air, United, Western, and Hawaiian. These "show cause" actions are rapidly being implemented and declared operative, particularly due to the lack of objections from the bulk of the carriers. The same 3 mill per lb/mi rate was ordered for Pennsylvania Central Airlines in a case pending for some time.

The Colonial Variation

Only variation from the standard rate in recent cases was that set for Colonial Airlines. In this instance a base rate of 21.61c per airplane mile was established and represented a continuation of the old air mail rate basis followed by the CAB. Presumably, Colonial is far from being economically self sufficient and has need for subsidy payments. The board also found in the Colonial case that "where the costs of a carrier are so far in excess of the average costs of the industry as a whole and of the highest costs recorded by any operator of similar equipment it is reasonable to question the economy and efficiency of management." It can be seen that the board is going to give close attention to cost standards.

This is further substantiated by the board's opinion in the case of another line, where analysis was made of expenditures classed under the head of promotion of local public interest and opinion for certain of the carrier's proposed services. The board declared:

"The record reveals that this carrier has included in its expenses for these purposes substantial amounts for gifts, dinners, banquets, and other entertainment. Such expenditures are not to be tolerated, merit thorough condemnation, and therefore are disallowed. Expenditures of such character to promote public support will invite adverse criticism toward the particular carrier involved and will reflect on the air transportation industry as a whole."

(Turn to page 347)

BARRON'S STOCK AVERAGES

			Aircraft	Air Transport	50 Stocks
Feb	4	1943	30.83	27.91	72
Jan	28	1943	30.45	28.72	72
Jan	21	1943	28.68	28.74	71
Jan	14	1943	28.80	28.50	69
Feb	6	1942	31.62	20.94	64

Fire Protection Equipment On PAA "Clippers"

AIR TRANSPORT

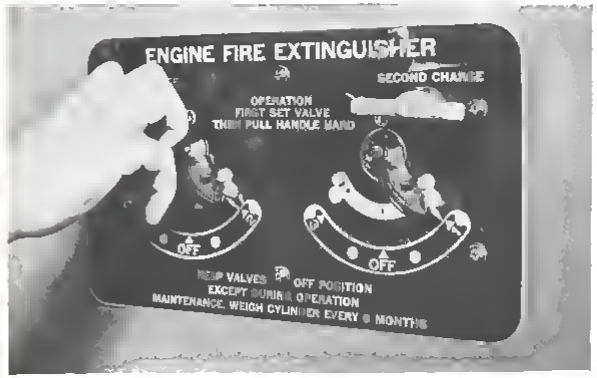

Fig. 1. Engineer in crew's compartment sets control valve for No. 2 engine and prepares to pull release handle. Gas discharge can be directed at any one of four engines.

Fig. 2. Here, engineer's assistant at New York *Clipper* base prepares to remove ship's CO_2 containers for periodic weighing check.

IF, BY ANY REMOTE CHANCE, fire should break out in one of the four 1690 hp. engines of a Pan American *Clipper* on a transatlantic flight, it's a safe bet that passengers wouldn't even know it. For the flight engineer would step calmly to a control board (Fig. 1), turn a valve, and blow out the fire with a blast of flame-smothering vapor.

That's how well-organized the fire-protection equipment is on these 42-ton flying boats that pioneered America's aerial life lines to Europe, Africa, and Asia. So careful have company engineers planned for every eventuality that this leading airline has, for example, completed approximately a thousand transatlantic crossings without a single fatality or serious accident of any kind.

The way this ingenious fire-protection functions can be seen during the regular "turn around" overhaulings which the *Clippers* get at the Marine Terminal of the New York Municipal Airport at the completion of each transatlantic trip. These overhauls which involve going over the entire ship with a fine-tooth comb in less than 24 hr., also include frequent inspections and testing of the fire extinguishing systems.

First step in the fire system's check-up is the removal and weighing (Fig. 2) of the carbon dioxide cylinders—heart of the extinguishing equipment. These containers, which hold liquefied carbon dioxide under terrific pressure, provide the vapor which is capable of smothering an engine fire even though the plane is in full flight miles above the Atlantic. If the cylinders show the prescribed weight, the inspector knows that no leakage has occurred during previous flights and an adequate supply of the liquid is available.

Another step in the fire system check-up which is done at less frequent intervals is complete discharge of the carbon dioxide through the plane's gas distribution system. One of the hundreds of maintenance engineers who swarm over the *Clipper* during these speedy overhauls aims the control valve first at one motor, then at the others, in order to make sure that the vapor instantly

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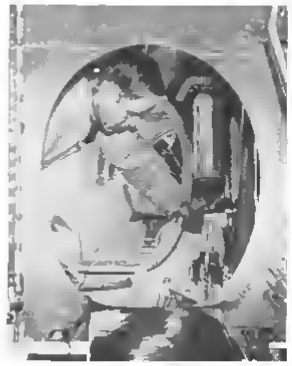


Fig. 3. What happens during an engine fire is shown by this view of engine nacelle interior during test of system. Engineer stands by while the CO_2 gas rushes from perforated tubing surrounding engine.

Fig. 4. Portable CO_2 extinguishers are also kept at hand throughout ship. Shown here is interior of a wing space behind one of engines.

AIR TRANSPORT

Slotted Hinge Speeds Removal of Cargo Doors

Fig. 1. Bruce Thomas, Douglas Aircraft Co., points to slotted hinges he designed to permit cargo doors to be removed instantly.

Fig. 2. Hinges as they appear with fairings when door of cargo plane is closed

New type has pin welded to one half, eliminating loose pieces and facilitating rapid removal of door from aircraft.

HINGES which make it possible to remove cargo doors and thus avoid interference with loading or unloading of planes—and which do so in a few seconds instead of the 15 or 20 min formerly required—are the invention of Bruce Thomas, Douglas Aircraft Co. No tools are necessary to take doors off these hinges.

A slot is cut in upper half of both hinges (Fig. 1) wide enough to allow passage of the tongue on male half. A pin larger in diameter than the width of the slot is welded to male tongue. Slots are cut at an angle of 90 deg. from the closed position. The tongues of the male halves line up with top and bottom slots only when the door is about half open. In that position, the door can be removed by merely lifting it upward. In full open and in closed position, the tongues do not line up with the slots and the door cannot be lifted off, thus insuring its security. (Figs. 2 and 3 are further explanatory.)

Since hinge pins are welded to the tongues, they cannot drop off, and they require no head. Hinge pins previously used had to be locked with nuts and cotter pins, with small attaching chains so that pins could not be dropped and lost if taken out to remove the door.

Fig. 3. Hinge in "half in half out" position. Tongue of male half is just passing through slot cut in upper female half of hinge. A right angle brace bolted to tongue is riveted to outside of door. Pin has no head, is welded to tongue.

Wheel Maintenance At American Airlines

By RAY MILLER
Supervisor of Overhaul, American Airlines, N. Y.

American's comprehensive classification of degree-of-wear in wheel assembly parts is salient example of centralled maintenance procedure. Company's innovations in equipment contribute to more efficient overhaul.

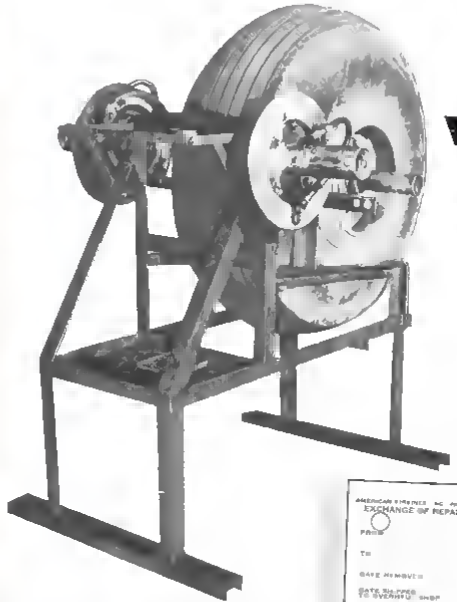


Fig. 1. Wheel assembly stand in American Airlines' line check department. (See Dec. AVIATION, Maintenance Notebook.)

IN THE American Airlines' shops at LaGuardia Field, N. Y., continuous wheel maintenance is handled in two ways, depending on the work to be done. Checking and adjusting are done on the line; overhaul of any kind calls for replacement and routing to the shop. If the line maintenance department determines that overhaul is necessary, replacements are made in complete wheel units.

Any wheel to be checked for adjustment or overhaul comes off the plane as a whole. It is then placed on a fixture and disassembled (Fig. 1). If visual and tactual inspection show only minor adjustment and servicing are required, this is done and the wheel re-assembled for installation.

If any parts require overhaul and machining, they are removed, tagged, and sent to the shop. Refinished matching parts are substituted and the wheel reassembled. The repair tag, shown in Fig. 2, carries complete identification of the part, so that the shop can check its history. The most important item is the cause of complaint, which is the first guide for the repair man.

To follow a brake drum through overhaul, assume the pilot complains of grabbing brakes. Line check indicates a drum out of round, requiring grinding. The line, axle, bearings, and fittings are removed, while drum and brake assembly are tagged with identification and complaint and sent to the shop. Here all drums are classified in a color code system according to micrometer measurement of inside diameter, as follows:

New drums—14.000 to 14.020 in.—Green
Drums 14.020 to 14.040 in.—White
Drums—14.040 to 14.060 in.—Blue
Drums—14.060 to 14.080 in.—Orange
Drums—14.060 to 14.100 in.—Red

Serial numbers are stamped into all drum edges, also the actual micrometer measurements after last grinding.

Despite grinding, shrinkage due to wide temperature fluctuation in service often results in smaller measurements than those preceding. This shrinkage may be unequal, leading to thin spots, after drum is ground to round, which are not indicated by measure. Therefore, drums are also classified as to weight, and a drum weighing less than a certain minimum is permanently removed from service. After several grindings are stamped on the drum, judgment of repair man may dictate removal of drum for weighing. Any weight less than a minimum of 12¾ lb. or an inside diameter of more than 14.100 in. automatically rejects the drum.

For drum grinding, Lou Trainor, machine shop foreman, has devised a very efficient machine (see Figs. 3, 4, 5) by

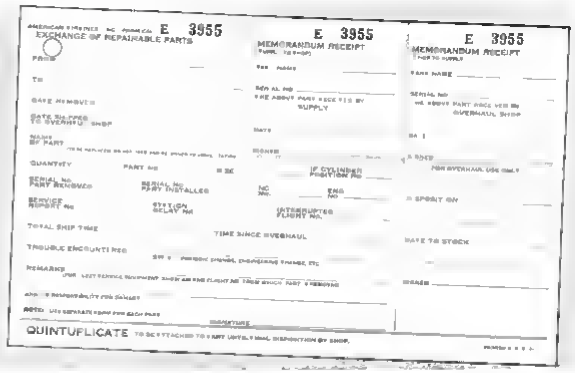


Fig. 2. Serviceable parts repair tag carrying identification and complaint. Two stubs in upper right corner are torn out and kept for records by line check and machine shop.

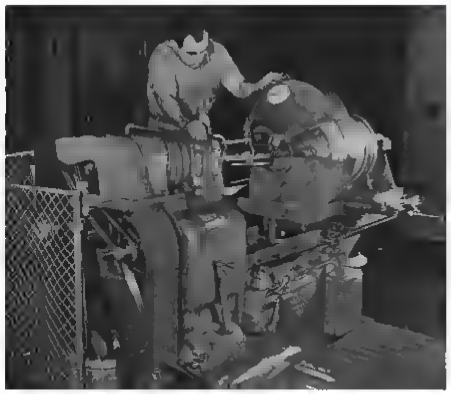


Fig. 3. Side-front view of Tramor brake drum grinder conversion. Belt drives furnish power to shaft in rear (which turns brake drum) as well as to grinder head. Controls are on side.

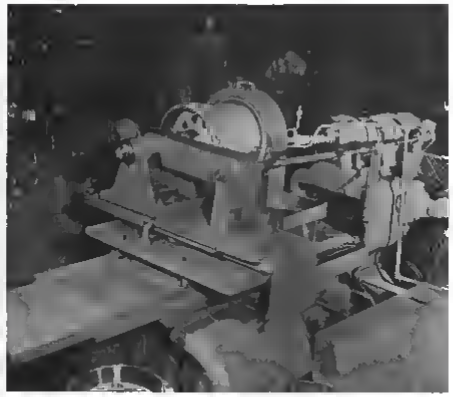


Fig. 4. Rear view showing bearing casting, carriage, and telescoping shaft with universal joints which allows free motion of carriage while rotating brake drum.

converting a cylinder honer to handle brake drums, which augments the work turned out by the standard grinder. The grinding head of this concentric honer is canted to one side, and a heavy bearing casting is installed lining up on this same side, on the movable carriage which used to hold an engine cylinder. The bearing supports a shaft which holds and turns the brake drum. Power is supplied from the grinding motor through belts, a telescoping shaft, and two universal joints, all made from discarded parts. The angle of the grinder allows the stone to reach inner surface of drum and still clear the convex center of hub. The standard grinder, after cutting through in one direction, has to be reversed by hand to complete the job in return cutting. The Tramor conversion is fully automatic and completes the job without further attention, after first setting for desired grind. The moving carriage has adjustments, like a lathe, for fine lateral and longitudinal distance settings.

If, after grinding, the inside diameter measurement falls within another size classification, the drum is properly repainted to correspond with the size-color code.

To cut expense, brake lining is drilled and fitted in the shop. The drill jig shown in Fig. 6 was designed in American's shops, and accommodates three sizes of linings: One for older single servel brakes, and the two sizes used on double servel brakes. Drill guides, which wear out rapidly due to abrasive quality of the lining, can be taken out and replaced by backing off the lock nut.

Brake shoes are checked for radius in a simple template developed from suggestions by the Bendix Co. (see Fig. 7). The steel plate, cut to exact radius, is raised on a wood frame to allow insertion of two light bulbs. Light showing between shoe and plate indicates the deviation. For alignment, a steel pin exactly the size of a brake shoe fastening bolt is set at 90 deg. in a level bench top. With shoe in place on the pin, any deviation from the flat surface indicates distortion, and the shoe is bent accordingly.

The machine for grinding brake shoes, developed by American engineers, has more complicated research behind it than appears on the surface. As shown in Fig. 8, it consists of a grinding wheel set vertically, a circular turntable with fittings and fastening hook for shoe, and a lever for turning against the stone. The hub of this turntable is milled to receive a micrometer arm which is a radius of the brake drum circle, and the micrometer adjustment fits against the outer surface of shoe lining, giving readings in thousandths of an inch. A fine dial adjustment on turntable regulates distance from the stone.

A second adjustment allows for slight eccentric displacement of table which can change the radius of grind. This adjustment is governed by scale marks which line up across the edges of a movable outer section of table and the stationary inner part. Four sizes are stamped on the machine case, which correspond with four of the drum size groupings, the fifth being standard new size. Every shoe lining ground must be one of these sizes. Thus calculation for the machinist is reduced to a minimum.

Finished brake shoes are painted according to size grouping and sent, with finished drums and brake assemblies, back to the line maintenance department to be properly mated and reassembled into completed wheel units, ready for installation.

Tire removal is facilitated by an ingenious tire bead lever invented by an American maintenance man, Lou Meade. Shown in Fig. 9, it consists of an old brake torque collar with a welded fin, to which is hinged a long pipe handle. Near the hinge, at the proper distance

(*Turn to page 330*)

Fig. 5. Close-up of grinding head showing angle of stone inside brake drum, giving clearance to hub. Stone rotates in fixed position, drum carriage moves in and out while rotating drum.

Fig. 6. Brake lining drill jig with drill guides which space holes for shoe rivets.

Fig. 8. Brake lining grinder. Round dial at lower center gives adjustment to and from stone. Milled hub receives fitted micrometer arm. Tube at lower right removes dust.

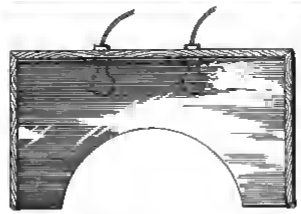


Fig. 7. Template for checking brake shoe radius. Steel plate is set on wood frame. Light bulbs placed in rear under plate (indicated by dotted lines) allow accurate check of fit to curve.

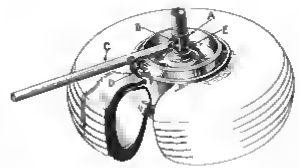


Fig. 9. Lou Meade's tire lever, consisting of brake torque collar A, welded fin B, hinged lever C, tire bead thrust piece D, bolt for anchoring, E.

MAINTENANCE

Correct Repair Of Transparent Sections

By PVT. BRUCE MACINTOSH

These proven methods of repair are used at the front and on the training field. They have the endorsement of both the Air Forces and the manufacturers.

FIELD PATCHING and cleaning are of primary import to the maintenance men whose job it is to keep up Plexiglas, Lucite or Lumarith turrets, noses, observation domes, and tail cones. The methods here are tried and true—are used at the front as well as on the training field. Both our air forces and manufacturers endorse them.

Repairing combat damage is the biggest job of maintenance of the transparent sections. Here, the procedure is divided into two major items—bullet holes and cracks. Bullet holes (see Fig. 1) are repaired in the following

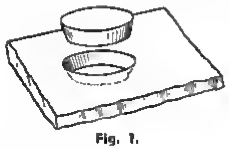


Fig. 1.

manner: Patch and hole should be trimmed with tapered edges, and the patch should be thicker than the material being patched, with the tapering on a sharper angle (Fig. 2). Heat

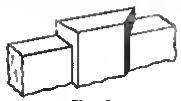


Fig. 2.

edges of patch until soft and force it into hole (Fig. 3). Hold it in place

Fig. 3.

until cool and hard, to assure perfect fit, then remove patch for cementing bath.

During cementing, pressure need be applied only on the top surface. Tape assures equal pressure on all sides. After cement has hardened, sand or file edges level with surface. Figs. 4, 5, and 6 concern methods of trimming holes, including what to avoid.

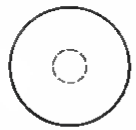


Fig. 4. For round holes.

Fig. 5. For tears.

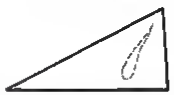


Fig. 6. Avoid sharp corners. Strains are apt to develop at corners, and it is difficult to obtain even pressure at all edges.

The plugging method is preferable where time and equipment are available, the area around the hole being cut out with a fly cutter.

Cracks are handled by drilling a small hole (⅛ in.) at the end of the crack, thus distributing the strain over a larger area (Fig. 7). Should the plane be going into strenuous combat, further support is given by lacing with aerial wire (Fig. 8). All the strains which originally caused the crack are concentrated at the point of the crack—tending to extend it. Therefore, drill all cracks at ends. Patches are of thin transparent plastic, cellulose acetate, or wing fabric. An acetate patch is shown in Fig. 9.

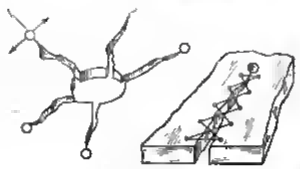


Fig. 7. and Fig. 8.

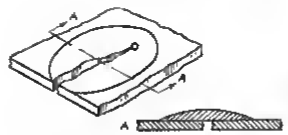
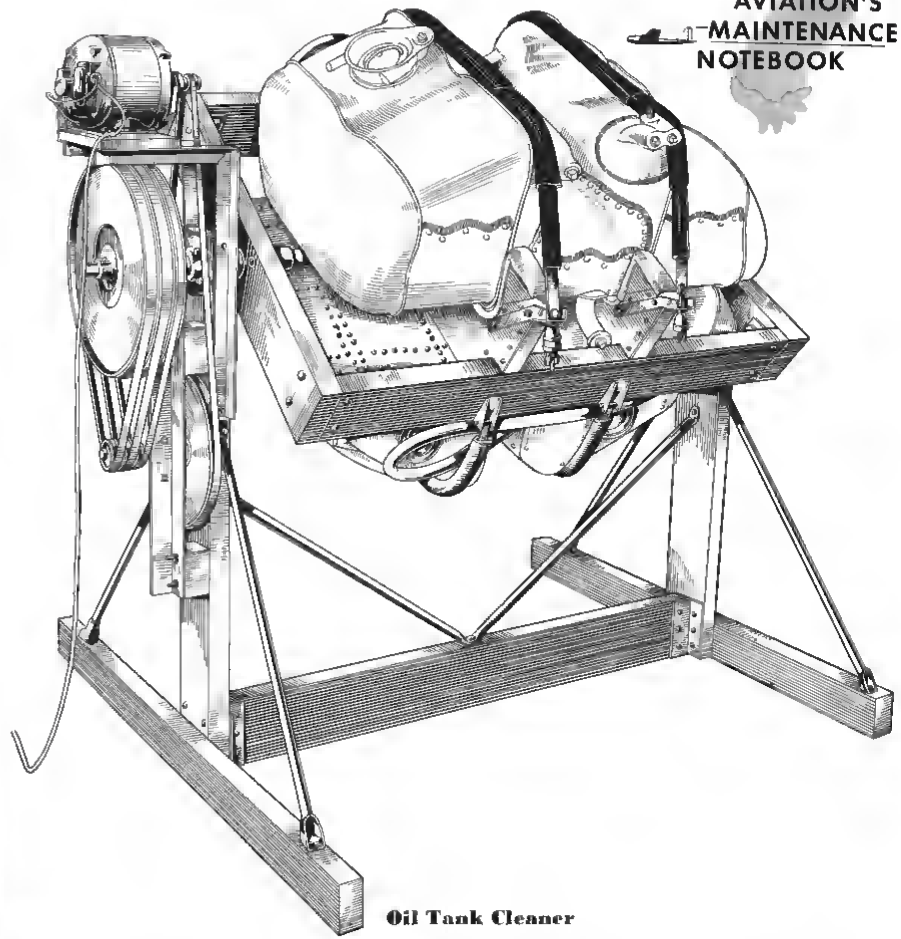


Fig. 9. Acetate patch, with transverse section through A A.

Proper cleaning is important in routine servicing, and the avoidance of using damaging cleansing agents cannot be stressed too strongly. The objectionable ingredients are either solvents or abrasives, and it is well to know the most common offenders. They are: Aviation and ethyl gasoline, acetone, lacquer thinner, benzene, fire extinguisher fluids or carbon tetrachloride. Should any of these get on the plastic, wash at once with water. To remove oil and grease, kerosene or white gasoline may be used, but soap and water are better, applied with any grit-free medium such as a clean sponge, a cloth, or the hand.

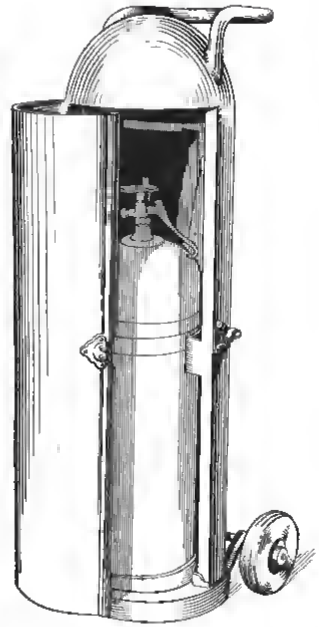
Removal of scratches that are not too deep is accomplished with a cleaner, followed by an automobile wax. Rubbing too hard, or too long is to be avoided, since the plastic will heat up if the action is confined to one spot. In field use are Simoniz Liquid Kleaner and Simoniz wax, which are good for hand operations where buffing equipment is not to be had.

Deep scratches are removed with fine wet-and-dry sandpaper followed by buffing with tallow and finished with a clean buffer. These operations are spread over as wide an area as practicable, with light pressure employed.



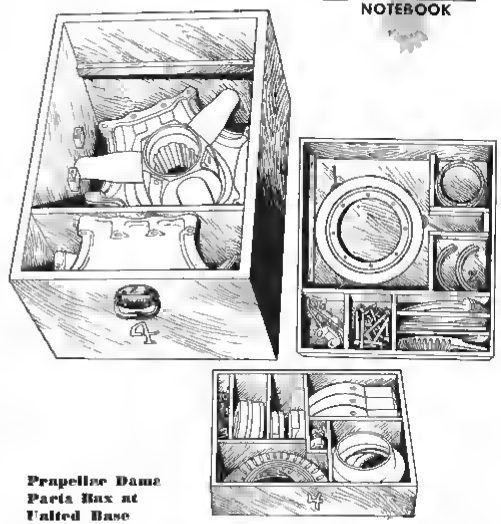
Oil Tank Cleaner

■ Here is a unique design in oil tank cleaners, worked out by the TWA maintenance crew at company's Missouri base, incorporating a power driven rotating table. Two tanks are strapped to rotating table after special cleaning fluid has been placed in each tank and all openings closed. Table is then rotated and cleaning fluid sloshed through tank baffles, assuring that all foreign material, carbon deposits, sludge accumulations, etc., are dislodged and eventually washed out. After first cleaning has been completed, tanks are thoroughly flushed with clear water, removing all cleaning compounds and flushing all loosened particles from tank. This is accomplished also by rotating tank on the same table, attaching to center core of table a standard water hose which supplies a continuous stream of clear water through the table and into the tank proper, tank being connected to table by means of a flexible rubber hose. During clear water flushing, oil tank cap is removed and clear water allowed to exit from tank at this point while rotating. The tanks are rotated with cleaning fluid for about 30 min. and then flushed with clear water for about 15 min., making total time for the operation approximately 45 min. Clean tanks are assured by this means.



Fire Extinguisher Cart Used at TWA

• TWA has designed this portable cart, which also serves as storage case when not in use. It accommodates a 20-lb. CO_2 type extinguisher, held in place by quickly detachable clamp, which also holds door of cart. Cart is used by personnel assigned to line service, who keep it adjacent to plane being serviced.

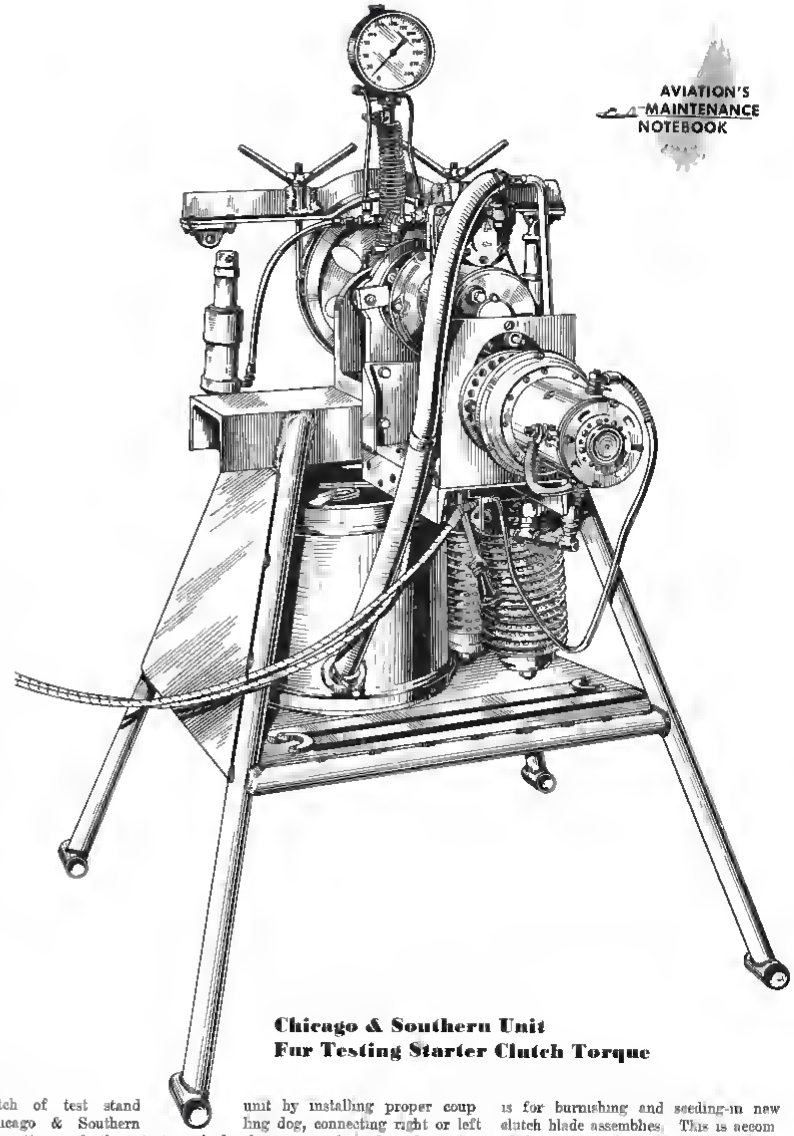


Propeller Dome Parts Box at United Base

• Complete parts of a propeller dome assembly are stored by United Air Lines in numbered boxes, with numbers corresponding to propeller assembly to which dome belongs. Box contains two compartmentalized trays which prevent any two parts from touching one another. Small tray contains all parts that do not undergo Magnaflux inspection. All others do, hence are kept separately for convenience. Maintenance of all parts of a single propeller assembly for as long as possible, without interchanging with parts of other assemblies, usually pays considerable dividends when it comes to propeller balancing.

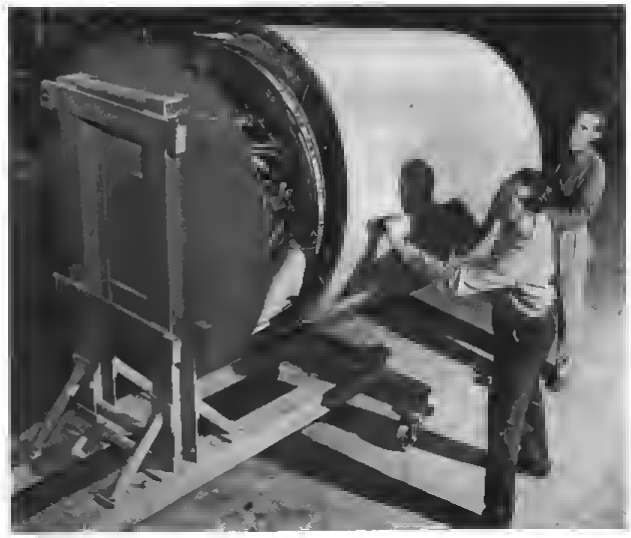
How Continental Saves Shop Space

• To conserve space at accessory test bench, Continental Air Lines has installed a surface plate at a convenient level on top of bench motor.



Chicago & Southern Unit For Testing Starter Clutch Torque

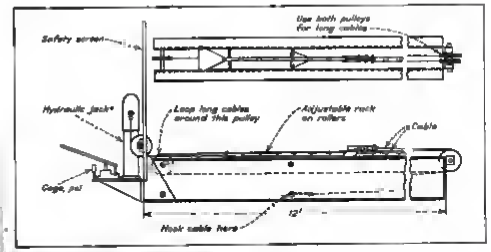
Detailed sketch of test stand used by Chicago & Southern for checking setting of the starter clutch assembly. A brake drum is connected to a torque arm, and end of arm is coupled to hydraulic rams. Torque readings are then read directly on a pressure gage, which registers pressure in the hydraulic ram. Starters of right or left rotation may be tested on this unit by installing proper coupling dog, connecting right or left hydraulic ram as desired, and turning selector valve to the ram connected. For testing of combination starter and propeller feathering units, this set-up has been equipped with a hydraulic system for testing operation of the pump by the starter motor. The added auxiliary motor, seen installed on front of stand, is for burnishing and seeding-in new clutch blade assemblies. This is accomplished by coupling this power unit to regular starter unit through feathering pump gear train. Direct reading of the torque, obtained while clutch is slipping, shows definitely whether plates have properly seeded, and slowing rotation through double reduction gearing insures that clutch will not be over-heated.



Engine Storage Can Devised by Consolidated

• Designed to protect overhauled engines in the field from fire, dust, moisture, low temperature, and sabotage, this "engine can" has been developed by L C Bly, Consolidated maintenance foreman, and his assistant, J F McClure, from suggestions by Russel R. Rogers, flight and service manager Made of sheet metal at cost of less than $30, it could be made of plywood or any handy material. It bolts tightly to metal disk fastened to engine stand, with hasps for locking Small housing inside can fits over propeller hub for bearing point to keep weight off rocker boxes and projecting parts A 100-w. bulb burning inside will prevent too low temperature and condensation

Cable Stretcher to use at United



• Designed and built by United Air Lines, this device is used at company's Wyoming maintenance base to pre-load and test cable It consists of two parallel steel 8-in channels 12 ft. long, a rolling carriage, and a bumper type hydraulic automobile jack connected to a pressure gage This makes it possible to load measured lengths of cable up to 6,000 lb., and to make necessary adjustments before, rather than after, installation of cable in airplanes Diagram shows plan and profile view, with location of hydraulic jack and pressure gage

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Improved Aircraft Life Rafts

MILITARY

Seven-man heavy bomber crew raft contains wide range of equipment for extended period on sea. Feature is water-sensitive valve which automatically ejects and inflates plane raft.

THE OFT-PROVEN VALUE of aircraft life rafts will be increased through two new improvements, one literally giving larger rafts "all the comforts of home," the other an automatic inflator and ejector to aid carrier-based fighter pilots.

First improvement is a seven-man raft, now in mass production, which was developed by the Equipment Laboratory, Wright Field, and the United States Rubber Co. The new raft is 12 ft. long, 5 ft. 8 in. wide and folds into a case 1½ by 3 feet. Total weight, including equipment, is 70 lb. Its design includes a horizontal bulkhead which divides the raft into upper and

(*Turn to page* 370)

Developed by Wright Field Equipment Laboratory and United States Rubber Co., this new seven man life raft for heavy bomber crews has double bottom, is equipped with square sail which can be rigged on oars, and is said to be roomier, more seaworthy, and less apt to capsize than previous models. Carrying case becomes sea anchor for launching or for holding nose into wind during heavy weather. Raft is 12 ft. long, 5 ft. 8 in. wide, and folds into case measuring 1½ by 3 ft. Total weight is 70 lb.

Heavy bomber crew inspects new life raft and "accessories" which include tarpaulin for protection from sun or rain, concentrated 30-day rations, water, fishing kit, first aid unit, signal kit and, in some cases, radio sending set. Besides essential carrying case which becomes sea anchor, essential equipment includes bailing bucket and plastic hand pump, all fastened to raft by lines. Knife, repair kit, and whistle are stowed in zipper sealed pockets.

Engineers of Walter Kidde & Co. have developed automatic ejector and inflator for carrier based fighter plane rafts. Water actuated valve on bottom of fuselage releases gas which opens life raft compartment and inflates raft, which is prevented from drifting away by light line.

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Mock-Ups Improve Ground Instruction

By WARREN C. YOUNGCLAUS
Chief Ground School Instructor, Spartan School of Aeronautics

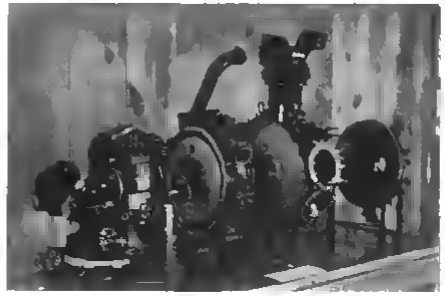

Fig. 1. "Exploded" engines are beneficial to both pilot and mechanic training, prove invaluable in demonstrating difficult problems

Fig 2. Carburetor and magneto mock-ups. Equipment like this shows the student inner workings of important parts, takes the place of hours of less efficient lecturing

Working models, panel boards, and assembly mock-ups save hours of lecture time, give quicker, clearer understanding. Here are new methods in this expanded ground study program offered by an instructor in a progressive school.

THE RECENT STEP-UP in aviation training programs undertaken by the Air Forces, the CAA, and the aviation schools, in conjunction with the industry at large, has projected the ground school training of these various enterprises into the spotlight. Each day, more and more emphasis is being placed on the ground training of our pilots, because the design and operation of our present day aircraft demands that the man at the controls be more than just a pilot.

This is especially true of our military flyers. The pilot of a military fighter plane has, as sole occupant, the responsibility of reporting on the performance of his craft under his particular working conditions. As nearly as possible this information should be from an engineer's viewpoint.

Besides teaching a man to fly, the vital point is to give him the necessary mechanical, mathematical, and meteorological understanding that helps make him a better pilot. It is the purpose of the ground school to give him this training. Previous to the expansion program, it was not uncommon for pilots to be trained almost entirely in the air with meagre training, if any, in actual ground school classes. The larger schools, of course, had a regular curriculum which they followed, but these schools were out-numbered by small operators, whose training was strictly air work, plus whatever the student could pick up around the airport or read in textbooks written for that purpose.

Today, the training of a finished pilot without ground school instruction is unheard of, thanks to the efforts of the CAA through its CPT program, and to the Air Forces through their

Fig. 3. Aircraft electrical systems on panel boards show details at a glance. Instructor in photo points out an adjustment on starter

training syllabus, as followed by civilian schools giving primary training for this branch of service. The precedent so established has resulted in regular organized ground training of most of the pilots now turned out.

Associated with the ground school is the term "lecture." The success of a student's ground training depends in large measure upon the type of lectures given him. In this connection we offer for illustration the various equipment being used by the Spartan School of Aeronautics in its many training programs. This equipment has been developed in the instruction of British pilots, American Air Force pilots, mechanics, CAA pilots, civilian pilots, and engineers. It is, in a manner, a cross section of the nation's aviation training program.

While comprehensive lectures, supplemented by outside study, greatly aid the student in laying out a foundation for his study, the use of cutaway sections, models, and mock-ups will impress the student with a lasting visual understanding. This is particularly true when discussing some complicated mechanism which the student has never seen. In his lecture work the instructor may eloquently explain a point, but for thorough comprehension there is no substitute for working models.

The extent and nature of this instructional material is obviously dependent on the type of instruction being given. Student mechanics need more elaborate equipment because their training requires knowledge of many points which do not concern the pilot. On the other hand, the pilot will require certain mock up equipment in subjects which do not concern the mechanic.

"Exploded" engines, as in Fig. 1, play an important part in both pilot and mechanic training. They give the student an insight into the relationship of the basic parts of the power plant and furnish great aid to the instructor. Exploded models of both aircooled and liquid cooled engines will complete the picture.

In addition to engines, mock-ups of

(*Turn to page 348*)

Fig. 5. Synthetic navigation board which makes possible execution of all navigation problems in the classroom

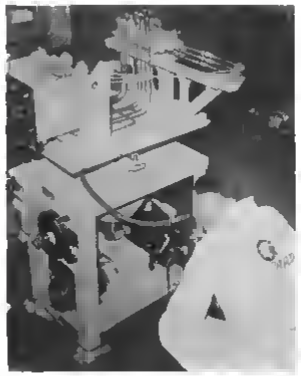

Fig. 6. Pilots get practical training in use and care of automatic pilot with above equipment

Fig. 4. Above photo shows a mock-up for giving student visual impression of three views of atmospheric condition. Instructor is pointing out heavy precipitation under thick cloud formation.

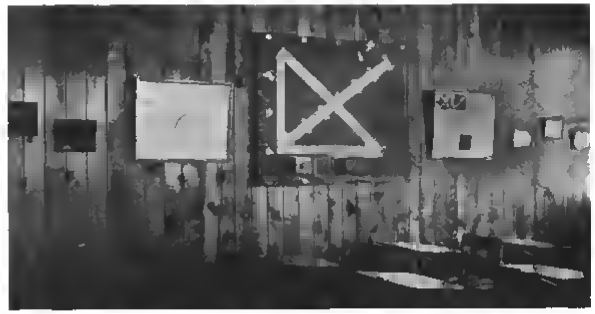

Fig. 7. Model airport with obstructions, runway, and boundary lights, allows practical discussion of field pattern, right of way, and other airport traffic problems.

CIVIL OPERATION AND TRAINING

On Patrol

■ Meeting an emergency by supplying a test pilot is the latest feather in CAP's cap. It happened in the St. Louis area when a manufacturer was hard pressed to complete tests in time for scheduled Army inspection of a new training craft. Maj. David W. Kratz, recently appointed Missouri Wing commander (see photo) not only put the ship through preliminary paces but also gave a command performance for Army inspectors. Result: the plane was approved and the producer received an order. . . . Statistics on CAP's accomplishments during the past year have been issued by OCD. During 1942 commands in every state and units at more than 1,000 airports were organized. The varied services of 66,000 citizens as well as several thousand cadets were enlisted. CAA is now awarding certificates to those cadets who pass examinations in ground requirements. For the services, CAP members spotted submarines along the coast and flew in numerable special missions. And no small number of them volunteered for service in the Army, Navy, and Air Transport Command. . . . About 130 flying cadets awaiting Army induction have got a head start in their study of meteorology, theory of flight, and military drill through the twice-weekly classes given by the Rock Island, Ill., squadron. . . . Two St. Louis officers had a wild ride on the ground recently when the city held its first practice blackout which lasted till 10:20. Anxious to get pictures for an edition scheduled to go to press at 10:30, the *St. Louis Globe Democrat* enlisted the cooperation of the local wing. CAP flyers made the photos, which they rushed to the paper in police cars. The next morning St. Louisans had graphic evidence that the test had been 98 percent effective. . . . *Cross Country Flying*, written by CAP member Carlton Wheeler of Penn Yan, N. Y., will soon be off the press.

DETAILS LATER

C. W. Cole, supervisor of Curtiss-Wright engineering personnel, points out a few features of a *Commando* military transport to three of approximately 400 college girls the company has enrolled in a special employee engineering course. The girls, picked from approximately 100 colleges throughout the nation, will spend ten months studying the principles of mathematics, physics, and aircraft engineering in recognized university engineering schools before going into regular aircraft engineering jobs.

NEW CAP OFFICERS

Major David W. Kratz (left), 29 year-old Missouri Wing commander, and Capt. Emmett F. Cary who directs the 317th Group in southwestern Pennsylvania.

Along the Apron

■ RAF pilots on leave have been spending their free time mine-mating boys with the harsh lessons of wartime flying—lads between 16 and 18 enrolled in the British Air Training Corps. More than 60,000 cadets, who will be eligible for the RAF or Fleet Air Arm at 18, have taken such experience flights with veteran pilots. Air Training Corps gliding schools have increased from one to 14 in the past six months. . . . Ten employees of Curtiss-Wright airplane division at Buffalo, N. Y., have been selected to attend a 15-week executive training course at Harvard Business School. . . . Other points on the education front: Columbia University, New York City, offers a spring session course in maritime and aerial navigation. Courses in structural analysis for graduate engineers and applied aerodynamics are now underway at New York University. Faculty members of Polytechnic Institute, Brooklyn, are conducting courses in advanced electronics at a Sperry Corp. plant. LaGuardia Field's Academy of Aeronautics receives the efficiency banner of the Air Forces Technical Training Command. . . . In Florida and Arizona Air Forces cadets are being trained simultaneously with RAF candidates. All students at both places will follow the British curriculum but retain their standing in their respective services.

Efficient Filtration, another Battle won . . .

THERE are many other aspects of battle than the clash of steel, artillery duels or fights to the finish in the air. Ask the engineers what it means to battle against the havoc wrought by torrential rains, hurricanes and those bitter enemies frost, ice and snow.

There are yet other enemies to be conquered — dust and, especially in the North African and eastern battle areas, SAND — the relentless fighter against efficiency of aircraft and mechanised units of the Army.

Vokes Filters have helped to win these battles against Sand. Special types of Vokes Air, Oil and Fuel Oil Filters are fitted to machines for the R.A.F. and mechanised units operating in desert battle grounds to the satisfaction of Government experts, pilots and the men who keep aircraft, tanks, lorries, etc., fighting fit.

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ALTITUDE: 40,000 FEET

Inside this new RCA plastic altitude chamber, aircraft radio equipment is taking a ride at 40,000 feet. As the pressure drops inside the sealed, transparent walls, expert eyes observe every part of the radio mechanism. Defects in design, details of faulty construction that would remain hidden until actual high-altitude flights, can be noticed at a glance *right on the ground*—and corrected *before* the radio is installed in a plane.

For pilots it means greater safety, better performance, *dependability* —where failure of the radio equipment might mean difficulty for a courageous crew.

RCA's new all-plastic test chamber represents another step forward in aviation radio research. Because it is entirely transparent—it enables engineers to study the *whole* set at once, to check for high altitude flash-overs and leaks at the same time, to look for tuning shifts and "breathing" parts in the set simultaneously.

This most advanced of high-altitude test chambers is typical of RCA's many facilities for aviation radio research. Today that research has but one goal—to help make America's armed might in the air the most powerful and effective flying force in the world. From that war-time research will come the knowledge, the skills, and the technique that will help *keep* America's wings the mightiest and most useful known to man.

RCA AVIATION RADIO

RCA Victor Division • RADIO CORPORATION OF AMERICA • Camden, N. J.

Jones is *Already* Planning for 194?

Right now, Jones, like the rest of us, has just one job — the job of winning a war. His factory is turning out machine gun parts by the thousand — day and night.

But he's mighty anxious to get back to making stokers. That's his regular business. And he's already putting in a lot of extra hours planning a better stoker than he ever made. He won't be caught napping. While the shouts of Victory are still ringing out, Jones will be ready. He'll know exactly what he wants to do — and he'll do it.

There are thousands of Joneses. They're the men who were making bicycles and monkey wrenches and air conditioners before Pearl Harbor. They've learned a lot about new materials and new methods during these hectic days of armament production. And they're going to profit by their experience.

> One of the important things that these men have learned is the advantage of using forgings instead of castings for certain parts. In the building of fighting equipment, *Forgings by Phoenix* have been given some of the toughest assignments. They have demonstrated their ability to provide extra strength and endurance without excess weight and bulk. Held to close tolerances, and with a minimum of machining necessary, they are an important factor in speeding up production and lowering costs.

In your plans for the future of your product, consider the use of *Forgings by Phoenix,* and when today's job is done, we'll be happy to serve you.

* * * FORGINGS by PHOENIX * * *

PHOENIX MANUFACTURING COMPANY
CATASAUQUA, PA.

KEEPING THE AXIS IN THE *Dark*

NO Allied planes will send lighted invitations to enemy anti-aircraft guns, yet thanks to special lights, designed and manufactured by GRIMES, pilots of the individual planes in formation have the lighting they need for certain identification. Shielded formation lights are only one of the many types of aircraft lighting equipment developed and manufactured by GRIMES. **Grimes Manufacturing Company, Urbana, Ohio.**

If ... Aircraft Lighting...

GRIMES

Makes it!

The AVIATION NEWS

BLAINE STUBBLEFIELD, Washington E EUGENE MILLER New York JOHN FOSTER JR., New York HERB POWELL New York

Washington Takes On a "Tough One" —The Qoestioo of World Air Problems

Washington (AVIATION Bureau)—The human race already befuddled over the question of what exactly to do with the earth must now try to deal with the heavens So far Vice-Pres Wallace Clare Luce Jack Nichols and Mrs Roosevelt—just to name a few—have done little more than scratch the surface of the question

Never In the history of aviation has there been such a jurisdictional dog fight as now goes on In Washington Development of the civil air law of 1938, after years of wrangling, was nothing by comparison

The legislators and executive officers of the government foresee a peace ahead followed by an aviation show almost too big for their imaginations Many of them are sincerely trying to figure out what to do in the interest of the country Meanwhile, It s a 'sure way' to make the headlines for those who speak up

Wallace wants to establish a cooperative postwar United Nations authority to operate a globe-girdling air network which would serve as a sort of police power against aggressors, and incidentally would carry the traffic

The Civil Aeronautics Board has had the Civil Aeronautics Act rewritten by Congressman Clarence F Lea of California, greatly expanding CAB s power, In readiness for taking over the Gargantuan job The board figures that if It does not have the power and the scope some other agency will take over

As this was written, a resolution to establish a permanent 21-member aviation committee was approved by the House of Representatives Rules Committee despite protests by committees already active in the air field Representative J Nichols of Oklahoma sponsor of the resolution reiterated that the new body would limit its jurisdiction to civil and commercial aviation

There had been opposition from the Interstate and Foreign Commeree Committee which has handled civil aviation In the House for years and which stands to lose its jurisdiction Also members of the Naval and Military Affairs Committee were against the resolution believing that a strong new aviation committee might lap over into the military field And of course both the naval and military groups feel that they could handle civil aviation matters as well as not

Meantime, the President has appointed an interdepartmental committee to formulate a foreign air policy which the United States will support at the peace conference

This is only the beginning Undoubtedly a cabinet office of aviation will be proposed All nations will be involved

Twn "New" Jap Fightnrs

Japan has a "new" two-engined two-place fighter the I-45, according to Maj Edward Rector Air Corps who recently returned to this country from the China Air Task Force It is reported to look something like the Me-110 Moreover another "new' Jap fighter (both have been seen for months now) is a single-engined craft resembling the Me-109

The I-45 is described as well-armed, with a rear-gunner in addition to customary fixed forward guns Despite its heavier armament It is no match for the P-40 *Warhawk*, which can turn inside It outfly, outclimb and outdive It The Japs have stripped some of the I-45's of all extra weight including most of the guns in order to use the craft for reconnaissance

"Seagull" Gnes Overseas

The U S Navys SO3C-1 *Seagull*, two-place mid-wing monoplane, is now also being delivered to the British Fleet Air Arm, according to Curtiss-Wright, its builder Designed for long-range scouting, the planes' removable floats make it adaptable for land or water operations The British have namad It the *Seamew* after a local breed of gull

QUICKER NAVY EYES

With latest combat improvements Consolidated s Model 31 is going into production for the Navy as its newest and probably fastest patrol plane This prototype of the series known as the PBY is powered by 2 000 hp engines Total weight is about 25 tons length is 74 ft and span is the same as that of the "Liberator,' 110 ft

Bell Bomber Plant Risee In Snnth

Following an inspection of new Marietta aircraft assembly plant, which will be operated in the South by Bell Aircraft Corp, Lawrence D Bell, president declared thet the new bomber assembly unit 'is a tremendous job, larger than all the units of our other group put together Bombers larger than the largest now in production will leave the assembly line and the plant will be capable of turning out many parts and tool machinery for airplane building.'

Containing more cubic feet than any similar building In the world, the new plant will have one of the longest assembly lines In the aircraft industry

It will be an assembly plant only, Bell said adding that "we will manufacture other parts for a complete airplane as we and other manufacturers have agreed to build parts for each other

In keeping with modern trend it is a window-less air conditioned "blackout plant," for continuous operation

Martis Sees Postwar Climb

Glenn L Martin has forecast a postwar commercial aircraft industry 'bigger than anything we ever dreamed' He believes the first 18 months following the armistice will be devoted to developing new designs for planes and to getting these designs into large scale production After that he foresees a relatively swift climb which within five or six years will bring the industry back to its wartime peak in number of workers

Gunnery for All Crewmen

All members of Air Force bomber crews including armorers navigators bombardiers, mechanics and radiomen will now be trained in aerial gunnery in addition to their other duties Meanwhile a fifth flexible gunnery school has been opened and a sixth one is scheduled to be established Score of enemy planes shot down by trained aerial gunners has run as high as 20 to 1 in favor of our bombers

Wilson's WPB Authority Augmented As Nelson Dismisses Eberstadt

Washington (AVIATION Bureau)—Latest reshuffle in WPB gives Charles E. Wilson chief of the 'Little WPB' for aircraft, even more authority. Appointment of the former president of General Electric Co. as sole WPB executive vice-chairman followed dismissal by Donald Nelson of vice - chairman Ferdinand Eberstadt and provided Mr Wilson with 'full authority to make the necessary decisions to carry out the WPB production programs for aircraft, escort vessels rubber high-octane gas, merchant vessels, and all other war items"

Mr Wilson's assumption of supervision over materials as well as continuation of his present production duties was approved, Mr Nelson announced, 'to solve organizational problems which have come about because carefully scheduled production is now the most pressing problem before use.

'In the early days of this organization and its predecessors, we faced problems of a somewhat different nature Even a few months ago the problem of controlling materials flow was of major importance. It does not now lose any of its importance but the emphasis has shifted, scheduling—both of end items and components—is the overall job of first importance that must be pushed

'In other words, materials control and production control today are all one integrated job They cannot be considered separately They must be directed as one job, not two"

Mr Eberstadt, who introduced the Controlled Materials Plan to serve to alleviate some of the priorities chaos, issued a statement a few hours after his dismissal He called attention to "the fine cooperation of industry and labor in our joint task" then reasserted his belief that the policies which he followed were 'the best for our war effort and I am certain that a close examination of the record will bear this out"

Productinn at Twn Plants Under Probe by Truman

Washington (AVIATION Bureau)—Following an OWI report that production at Willow Run is "only a small fraction of its ultimate potential," Sen Truman and his investigating committee have begun an inquiry as to why output both there and at the Curtiss-Wright Ohio plant has not been greater "There has been so little production at either plant as to amount to virtually none" the Senator said.

OWI gave four reasons for the disappointing production rate at Willow Run: 1 Difficulties of obtaining materials and labor, 2 necessity of training a "green' working force with personnel now grown to 30 000, 3 comparatively permanent and inflexible tooling which has taken longer than estimated to install, 4 unexpected but necessary changes in designs

Ford officials operating government-owned Wllow Run made no comment, but J P Davey manager of the Curtiss-Wright plant, asserted that it had 'completed and delivered large numbers of two highly complicated and entirely new types of combat aircraft for the Navy Deliveries of one type," he continued, "are up to schedule and the other is nearing a satisfactory production figure"

Mileage Per Airliner Up

Average mileage flown per plane on the nation's airlines rose from 1 13S to 1,565 per day in the period from May to Oct 23, 1942 even though more than 50 percent of the lines' flight equipment had meanwhile been transferred to the Army, according to a report of CAB Figures show 324 planes were in domestic airline operation last May flying 3S5 567 scheduled miles per day in contrast to 16S planes in service in October flying a total of 264,709 scheduled miles per day.

Caretnker-Mechanics To Accompany Warplanes

Army Air Force has issued an order that every new combat plane larger than a single-seater will be accompanied by a factory-trained enlisted mechanic until it is delivered to its operating unit or modification center

These caretaker mechanics will come from the ranks of the Air Forces enlisted men who have been trained in the plants producing the respective airplanes Assignments will be by the Air Forces Technical Training Command. Each mechanic will act as crew chief and general caretaker and will have specific duties to assure that the airplane and its equipment are in good shape on leaving his care

It is learned on good authority that most plane manufacturers heartily approved the arrangement only desiring that the enlisted caretaker-mechanics are not recruited from the factory's regular working forces

Before the airplane leaves the factory the caretaker will see that its equipment is complete, or that it carries a placard showing any items short plus authority for delivery without such items He will see that the proper record forms are in the airplanes and that necessary instructions and handbooks are provided

If the plane goes to a modification center for changes the mechanic will accompany it, will see that records of the changes are made that the list of "short" items is corrected as missing items are installed and that other essential matters are effected.

Relative U. S.-British Plene Production Revealed

In a speech before the American Society of Newspaper Editors, Col John Llewellin, resident minister in charge of supply and chairman of the British supply council, said that in the past year, compared with America, the British had manufactured no transport planes a few trainer planes, 3E percent as many light bombers 7E percent as many heavy bombers, 1?5 percent as many medium bombers, and 106 percent of pursuit ships

The 105 percent of medium bombers is especially interesting, as it appears to refer to production of *Mosquito* all-purpose attack planes in large numbers The *Mosquito* is made entirely of wood, has two engines, a speed of about 400 m.p.h., and a rate of climb and ceiling exceeded somewhat by the Lockheed *Lightning*. *Mosquitoes* have been straffing and bombing all over Europe, reporting excellent results.

Fact that the British have manufactured no transport planes is causing them considerable apprehension in view of the large output of these craft by the United States and their operation on airlines all over the world.

UAL Also on .3 Mill Rate; Ask 5 Lines tn Cnt Fores

United Air Lines has been added to the growing group of airlines put under the 0.3 mi" per lb/mi mail pay rat' Others are Eastern, American, and Penn-Central It is expected there will be more soon It is estimated that the reduction from United's existing rate will cut the company's earnings by $1 700 000 a year, new rate applying to UAL's entire system and taking effect as of Jan 1, 1943.

Board Member Harllee Branch dissented in the board's decision He felt that the rate should be cut further holding that the .3 mill rate will still result in excessive earnings for all the lines to which it is applied Some of Mr Branch's associates say that his point of view agrees with that of Post Office Dept., which contends that the cost of operating the air mail system is excessive. Some investors feel that enterprises which collect "subsidies" are uncertain investments.

Behind the scenes—in the CAB in Congress and elsewhere—a disagreement is developing on the question of whether the air transport system should be maintained primarily as a nucleus for military purposes (it has been a e saver in this war) or aether it should be purely a blic utility

Five airlines — Eastern merican, Penn - Central, nited, and TWA—have now een told that they should consider a reduction in their passenger rates This call came after the board had examined earning statements in connection with air mail rates The board is not permitted to take simultaneous action on mail and passenger rates CAB hopes the lines will adjust their passenger rates voluntarily.

11 New Depot Areas; Kelly Field to ASC

Eleven new air depot control area commands have been established as part of a general reorganization of the Air Service Command, according to Maj Gen W H Frank Commanding Officer, Air Service Command These depot control area commands supersede th First, Second, Third and Fourth air service area commands with headquarters in New York, Texas, Georgia, and California Announced too is the transfer of jurisdiction of Kelly Field

The Air Service Command will continue to carry on its work through the depots and sub-depots which have been operating within the old air service area command but immediate jurisdictions over the sub-depots now is delegated to the new air depot control area commands

The eleven new commands are: Patterson Field, Ohio Duncan Field, Tex., McClellan Fld, Calif., Olmsted Field, Pa., Brookley Field, Ala., Hill Field, Utah, Robins Field, Ga., Tinker Army Air Field, Okla., Rome Army Air Field N Y., Spokane Army Air Field, Wash., and San Bernardino Army Air Field Calif.

Kelly Field, our oldest military flying base and the "birthplace' of more military aviators than any other Army field has now been transferred to the Air Service Command and will be combined with Duncan Field The two will be operated as a single unit as the San Antonio Air Depot

Duncan Field, now home of this Depot, will continue in operation, but will gradually take over the field and buildings at Kelly The San Antonio Air Depot is the main depot for the Southwestern United States and its activities cover virtually all of the Eighth Service Command An air depot maintains airplanes that cannot be overhauled by their squadrons Duncan has all types of training and operational equipment

The San Antonio Cadet center remains under jurisdiction of the Flying Training Command, and the General Instructors' School, now at Kelly Field is to be transferred as soon as other quarters are located.

Andrews, Brereton, Eaker Named to New Commands

U S Army Signal Corps Photo
LT. GEN. ANDREWS

USAF Photo
MAJ. GEN. BRERETON

USAF Photo
MAJ. GEN. EAKER

Washington (AVIATION Bureau)—Shifts in commands, following the Casablanca conference, have put three U S Army Air Force officers—Lt Gen Frank M Andrews, Maj Gen Lewis H. Brereton, and Maj. Gen. Ira C Eaker—in key positions on the European and African fighting fronts.

Gen. Andrews has been placed in command of the U S Army in the European theater, where he has announced an intensification of the air war over occupied territory as fast as planes and materials become available With RAF officers he will share the responsibility of demonstrating the destructive power of independently operating air forces and thus perhaps settia one of the chief strategy controversies of the war

The general brings with him long experience with bombardment groups He was one of the pioneer developers of the long-range precision bomber, the first commander of the General Headquarters Air Force, and later commander of the Caribbean defense area and Canal Zone

Now commander of all U S Forces in the Middle East (succeeding Gen Andrews) is Maj Gen. Brereton, formerly in charge of the Ninth Army Air Force in that area And Maj Gen Eaker has assumed the Eighth Army Air Force command formerly held by Maj Gen Carl Spaatz, whose transfer from England to North Africa to become chief of the new Allied Air Force, combining American, British, and some French units was noted in our February issue of AVIATION

As we go to press, word comes that Col Hugo P. Rush, who has been chief of staff of the Ninth Bomber Command in the Middle East, has been named chief of that force He succeeds Brig Gen Patrick W Timberlake, whose next assignment has not been announced

AAF Records 3-1 Box Score for '42

Box scores for United States and enemy combat aircraft for 1942 show that the AAF shot down three planes for every U S plane lost in combat During Dec. 1942, the ratio was 4-1.

Total enemy planes shot down or probably destroyed in 1942 is 1 349 as compared with a loss of 309 of our Army planes, according to official figures This represents 480 enemy bombers shot down and 228 probables compared with 110 similar U S losses, 2E4 enemy fighters and 75 probables against 164 U S losses; 213 miscellaneous enemy planes shot down and 81 probables against 35 similar U. S losses

For December 41S enemy planes were shot down or probably destroyed, with a loss of SE planes. Here, the breakdown is 145 enemy bombers shot down for the month and 35 probables compared with 37 similar losses; 83 enemy fighters and 10 probables against 48 of our planes lost, 38 enemy miscellaneous and 4S probables compared with 13 similar U S. losses

According to AAF policy, claims of "probables" are made when enemy planes are observed going down in spins out of control or on fire after combat. Counted as "shot down' were those seen to disintegrate in the air crash to the ground or into the sea, or seen abandoned by the parachuting enemy flyers

First With Dreft Timetable

Induction of personnel into the armed forces through a schedule taking into consideration the time necessary to train replacements has been put into operation by the Kollsman Instrument Division New York which "scored a first" in launching the plan after collaboration with local boards The timetable lists the employment status and draft classification of all employees not given occupational deferments and is to be revised every six months.

Plane Makers Weigh Tentative Auto Deaigna

It is now semi-public information that at least three "old line" plane makers are working out designs of automobiles they might build after the war. These firms do not care to be named, being apprehensive of the impression that might be created. However, it is noted that only a very negligible amount of engineering time is being spent on such work.

While auto firms now making planes can readily go back to the job of making cars, the airplane people, expanded out of all proportion to the regular market, must plan on somehow liquidating their excess capacity or going into the production of other merchandise This is also true of many new enterprises started up to subcontract to the aircraft industry. Expressed in

Press Association Photo
Eleven new B-24 "Liberator' bombers "toe line" on Willow Run's snowy air field prior to pre-acceptance tests

dollars, almost half of our enormous war production program is now classed as aircraft and the proportion may increase

Airplane firms interested in designing automobiles feel they can produce a new *kind* of car, not just another model, and that peacetime might be the time to do it They have developed many new production techniques and new materials It is envisioned that light steel construction will vie with aluminum, plastic, and magnesium in cars and in other equipment.

American Aircraft Production Reached Total Value of $5,000,000,000 in 1942

Washington (AVIATION Bureau)—Planes, engines, and propellers worth $5,000 000 000 were produced by American manufacturers during 1942 according to estimates released by the Aeronautical Chamber of Commerce This is an increase of 186 percent over 1941, when deliveries were valued at $1,750 000 000

During the current year, it is calculated that sales will more than double '42, approaching $12 000 000,000—further establishing aviation s dollar-value rating as the nation s first manufacturing business The present industry backlog is estimated at $22,000 000 000

Since 1939, total employment by plane manufacturers has blossomed to 830 000 and will reach 1 000,000 at peak expansion, and 175,000 of present employees are women, who will be approximately 35 percent of all new personnel during this year Poundage of airframes produced will probably be tripled during 1943, and the Chamber made the following prediction on how it will be used. "The present year will see larger bombing planes carrying huge bomb loads faster than the speed of most of the current fighter models, and warplanes having speeds in excess of 450 m.p.h will be announced"

West Coast manufacturers made a significant contribution to the national increase in the production of engines airframes and propellers Aircraft War Production Council, West Coast, Inc , announces that output of its members—Consolidated, Douglas, Lockheed Northrop, North American Ryan, Vega, and Vultee—increased 147 percent by dollar volume and 240 percent by weight during the first 13 months of war Daily deliveries now average $5,500 000.

Eddie Allen

The greatest test pilot of them all, E T Allen fell to his death Feb 18 along with ten others while on a routine test flight over Seattle Taking Allen himself, and his contributions, this must be considered one of the major losses the aviation industry has suffered

Eddie was chief of research division and director of flight at Boeing at the time of his death It would take pages to tell in detail all that he did to make himself the top ranking research man in the industry Suffice it to say that the entire industry had a claim on him when he was needed

Frequently borrowed from Boeing to test other companies ships, his most recent contribution was putting the Lockheed *Constellation* through her initial paces Former NACA test pilot and first winner of the Chanute Award presented by the Institute of the Aeronautical Sciences for outstanding pilot contributions, Eddie Allen's biography would, of necessity, chronicle the outstanding achievements in the science of aeronautics and of aviation's progress

Announce New Aero Fuels

A process for substantially increasing the nation s supply of 100-octane aviation gasoline also a method of refining designed to produce an aviation fuel of extreme power, are announced

In working on the production of butadiene for Buna S synthetic rubber, the Houdry Process Corp last year obtained an extremely high octane gas by the adiabatic catalytic cracking of heavy naphtha, which is now available in large quantities Designs of contemporary engines, states Eugene Houdry president, have to be modified to get full power from this new fuel "The process," he continues, "will make possible increased production of aviation fuel without increasing the need for crude oil production or placing a further drain on crude oil transportation facilities."

The new refining process was announced by the Universal Oil Products Co , Chicago The fuel produced—resulting from the blending of carbon and hydrogen atoms by a special formula—has been named Dixane It is reported to offer exceptionally high power.

C-54 Flew F.D.R.

Recent news that the President had made a large part of his Casablanca trip aboard an Army C-54 (DC-4) transport is the first indication that this plane has passed all tests and is in general use besides being of a class suitable for our Chief Executive's travels

Next to the *Constellation* which is not in general service yet, the C-54 is the largest four-engined transport now employed by the Air Transport Command

Aircraft Parts Salvage

Parts valued at more than a million dollars have been salvaged during the past two years from crashed and damaged British aircraft.

★★ IN BRIEF ★★

Since the President made his call for 50,000 warplanes, P&W has shipped more than 50 000 engines, reports the Aero Chamber . . . Accommodations for 1,000 students are provided in the new B-17 Mechanics School just opened on the West Coast by Boeing and the AAF Technical Training Command . . . Roundup of airplane skin men and subassemblers has been launched by the U S Employment Service, hence your needs for specialized workers might well be checked with local USES offices . . . Check of average weekly hours worked during November, the latest month reported, showed the aero engine field chalking up 51 2 hr , second only to machine tools which scored 52 8 hr

WPB states that since 1936, production of aluminum has been tripled and output of magnesium multiplied nearly 100 times. During the last year, six new government-sponsored and owned aluminum ingot plants went into production . . Boeing, of Washington, reports that plant workers have turned in nearly 10,000 suggestions for bettering production, conserving materials and time, and the like More than 400 have been adopted and about $6,000 paid by the firm in awards. Ideas remain the property of the originators, with the company retaining shop rights . . . Montgomery Ward's spring mail order catalog includes (take a deep breath) three pages of airplane parts to be sold to civilian flyers.

Working in cooperation with British, Canadian, and Australian plane makers, the National Aircraft Standards Committee reports effecting progress toward standardization of parts and materials for American and British combat craft . . . A "modified all-wing type" cargo plane in the 400 000-lb class is announced by Andrew J Higgins as "In the planning stage" . . . Willard Storage Battery Co. has begun production of aircraft parts in its new aluminum castings foundry

Briggs Mfg. Co has won the Army Air Forces Technical Training Command Efficiency Banner for having the highest record of any school in the AAFTTC Second District . . . Army co-pilots for the ATC are being trained by United Air Lines at its Colorado school . . . NAA's B-25 *Mitchell* bombers which have seen action on ten major fronts, will now also be used by the U S Navy For the sea service new designation will be PBJ-1 *Mitchell*

Army Accident Rate Down

Washington (AVIATION Bureau)—Without giving specific numbers Robert A Lovett assistant Secretary of War for Air reports that the accident rate for Army planes is now lower than the average for the ten years, 1930-1940

Despite a tremendous increase in military flying number of mishaps per 1,000 hr has decreased 11 percent The fatality rate however increased 05 percent This Mr Lovett explained in a letter to Sen Maybank, who had asked the War Department for information, was due to two factors Speed and size of modern ships and the larger crews they carry

"In the first eight months of 1942 (the latest completely tabulated figures available) there were" Mr Lovett wrote "74 3 percent more hours flown than in the whole ten-year period from 1930 to 1940, and 98 5 percent more miles were flown from January through August 1942 than in the entire ten years This eight months' mileage was equivalent to 48,000 trips around the world"

Freeze Private Planes

Washington (AVIATION Bureau)—At the request of the Army all light pleasure planes also Luk trainers have been frozen in the hands of their owners through an order issued by Charles E Wilson, chairman of WPB's Aircraft Production Board

Planes affected are those powered by single engines of 500 hp or less There are about 22 000 in the country and a good many of them have undoubtedly been released for sale by the recent Army order reducing the number of CPT schools from 600 to about 100

Thus this latter fact restrictions on gasoline, and Mr Wilson's action now practically dictate to whom owners may sell their own planes—the Army, Navy, government agency, or an approved individual

Walter Kidde

Word is received of the death of Walter Kidde 85 founder and president of Walter Kidde & Co well known maker of life-saving and fire extinguishing apparatus widely employed by the air services Noted as an engineer and manufacturer Mr Kidde held honorary degrees of Doctor of Engineering and Doctor of Science Besides being active in the construction and manufacturing fields and in the representative societies he also held many civic posts.

Wooton Heads WHCA

Newly named president of the White House Correspondents' Assn is Paul Wooton Washington correspondent of the McGraw-Hill Publications Mr Wooton has served the WHCA for several years handling the business side of the Association s affairs as its secretary and treasurer and he has acted in similar capacities for the Overseas Writers and other organizations through his centrally located offices in the National Press Building Founded in 1914 the WHCA's membership now numbers more than 500 accredited correspondents covering the agencies of the executive branch of the government.

International News Photo

STRIPPED FOR ACTION

United Airlines DC-3 "Mainliner," bare of seats and furnishings which accommodated her former passengers is loaded with a portion of the three tons of cargo she now regularly carries on contract route flying for the Air Transport Command.

Press Association Photo

TWO GOOD SHOTS

An A-20 strafes Jap planes near Lae, New Guinea Photographer also catches three enemy fighters in background (circles), a demolished "Zeke" (under tree at lower right) and a revealing profile of a disabled Type One bomber, about which few details are known

The Washington Windsock

By BLAINE STUBBLEFIELD

"Why not," said Gen Hap Arnold when asked if it would be all right to print his statement that we are turning out pre-flight students at the rate of 40 000 a year "It shows the Germans how many we've got A lot of people who are mad at the censor think we should tell the Germans how many we've got of a lot of other things

Remember the Boeing 80-A trimotor, circa 1927? If so you will be interested to know that one of them is still flying in Alaska

If an international police force takes charge of things when war ends its long arm and mainstay will be aviation which can reach a rumpus anywhere on earth in 48 hr The farthest point from any point in the world is 12 500 mi. We will have planes that can do that in one jump

Something ought to be done about the new high speed cameras that take pictures of planes in flight with their propellers standing still They look dead and awkward.

Some congressmen are worried lest other countries use our lend-lease airplanes in commercial competition against us after the war Most military types are useless commercially but some are easily convertible and fairly efficient The same congressmen want to know what about the lend-lease airports we are building in various countries

Figuring roughly, the Allies have built more than 150 000 airplanes in the last two years When you see that a total of 4 000 went to Russia 2 800 from the United States and 2 000 from England and when you read communiques about 10 20 50 or two or three hundred planes here and there you wonder what has been done with all those ships The airplane situation would drive an accountant crazy England gets unstated numbers of them from us but gives some to Russia and then the British Navy appeals to the United States instead of its own industry for more planes The answer to the whereabouts of the 150 000 of course is that they are scattered at scores of stations all over the world

Land-lease is a queer deal, looking backward from the war's end Of course no one ever thought of getting the groceries oil and clothing back The experts say we don't *want* the airplanes and trucks and machine tools and other durable goods back, we want industry to build new ones The man who said in the beginning that it reminded him of lending a piece of pie had it about right

Washington is a nut basket taking a quick look from sidewalks and corridors as most visitors do A casual bout with the telephone stores and federal offices will convince you that all the left-overs and incompetents in the country have come here to work But back of the scenery fortunately is some of the best ability the country can find In aviation to mention a few you have C E Wilson T P Wright George W Lewis Edward P Warner and others plus many able Service officers There are a few scholarly and able men in the House and the Senate but the congressman who has informed himself soundly on aviation is a *rara avis*

The Stubblefield Award goes to the House of Representatives Select Committee investigating air accidents for discovering that adverse weather conditions were a factor in the majority of the accidents which it has investigated and for duplicating at public expense the efforts of other agencies which have the required technical knowledge for such work

PRODUCTION-BATTLE CITATIONS

Continuously the aviation industry increases its pace of production. And not far behind follows recognition of its achievements — notably the coveted Army-Navy "E" pennant for factory flagstaffs, plus buttons for employees' lapels. Traditionally these awards went only to excelling ships and their crews, but, since the start of the battle of production excelling weapon makers have been equally honored.

White stars signifying six months' continuation of the efficiency responsible for their initial citations now sparkle on the pennants of—

Howard Foundry Co.
Fulton Sylphon Co.

Other manufacturers recently receiving Army-Navy "E" burgees and buttons are:

Acme Pattern & Tool Co.
American Seating Co.
Aro Equipment Corp.
A. Schrader's Son
Automatic Electric Co.
The Austin Co.
Bakewell Mfg. Co.
Bantam Bearings Corp.
Bound Brook Oil-Less Bearing Co.
Buffalo Forge Co.
Cleveland Automatic Machine Co.
Continental Rubber Works
DeVilbiss Co.
Dow Chemical Co.
Edwards and Co.
Emerson Electric Mfg. Co.
Fairchild Engine & Airplane Corp. (Plant 2)
Formica Insulation Co.
Henry Disston & Sons
H. M. Harper Co.
International Business Machine Corp. (Plant 1)
Lycoming Div. — The Aviation Corp.
Mechanite Co.
New Departure Div., General Motors
Nylon Research Laboratory (duPont)
Owens - Corning Fiberglas Corp.
Pioneer Parachute Co.
Rohm & Haas Co.
St. Marys Mfg. Co. (Goodyear)
Summerill Tubing Co.
Sunbrook Mills

CORRECTION

Since some misinterpretation seems to have resulted from a statement appearing on the editorial page for January AVIATION, we present the following clarification of the situation from a letter signed by Sir A. W. Street, permanent Under-Secy. of State for Air:

"1. The British Overseas Airways Corporation was established on 24th November 1939 under the British Overseas Airways Act which received the Royal Assent in August of that year.

"2. The members of the Corporation are appointed by the Secretary of State for Air. The Airways Stock is fixed-interest security guaranteed by the Treasury, carries no voting rights and is owned by nominees of H. M. Government. No profit earned by the Corporation can accrue or be distributed to an individual.

"3. On 1st April, 1946 the day on which the Corporation took over the undertakings which it succeeded the Secretary of State for Air by order made under Section 7 of the Air Navigation Act 1920 required the Corporation to place the whole of its undertaking at his disposal. From that date all the air services and other operations of the Corporation have been undertaken in compliance with the Secretary of State's directions.

"4. A large proportion of the fleet of aircraft and of the buildings and equipment at present used by the Corporation is directly owned by H. M. Government, and has been allocated to the Corporation for the express purpose of maintaining the communications required by the Secretary of State for Air.

"5. The operations of the Corporation are financed by H. M. Treasury and the Corporation accounts to the Secretary of State for Air for all revenue and expenditure in connection with them.

"6. The traffic carried by the Corporation is determined by H. M. Government which has exclusive control over priorities. To a preponderating extent, the loads consist of official passengers and goods and of troop and other mails.

"7. Thus, the Corporation is in no sense a commercial undertaking. It operates as a service to H. M. Government."

Calling Names

Mrs. Helen Gundy has been named to a new position as personnel consultant for Northwest Airlines' many women employees.

Victor Emanuel, president and director of The Aviation Corp., has been elected to the Commerce & Industry Assn. board of directors.

G. L. Lantz, C. O. Nelson and **Charles T. Gosser**, of General Electric contract service department, have been commended by the AAF for their servicing airplane turbo-superchargers in the war zones.

Jack Baillie, former contracts administrator at Vultee's Inland division, has resigned to head the Washington office of Hill & Knowlton, public relations counselors.

Dr. Charles N. Kimball, vice president and executive engineer of Aircraft Accessories Corp., has been elected to the board of directors.

Harold P. Wade is the newly appointed general manager of Adel Precision Products Corp.

H. L. Hervill, pioneer aircraft die cast manufacturer recently re-entered the industrial field when he announced formation of a new firm under the name H. L. Hervill Co.

Raymond S. Livingstone has been elected vice president in charge of personnel of Thompson Products in recognition of his record as personnel director of the company and its subsidiaries since 1934.

R. M. Ellis joins Aircraft Arts Development as chief mechanical engineer.

Will C. Sievert joins United States Aviation Underwriters.

H. Arthur Hook becomes manager of the Civil Aeronautics Administration's 6th region.

TAL announces the following appointments: **Malcolm W. Stevenson**, acting district manager at Chicago, succeeding **George E. Hatch**, on leave as a lieutenant in the Naval Reserve; **Ray Dunlap**, acting district traffic manager at Denver; **K. M. Sales**, formerly in Toledo, transfers to Philadelphia succeeding **H. H. Murphy**, on leave as 1st lieutenant in the AAF. **Miss Cherie A. Smith** replaces Sales at Toledo. **John H. Glendish** at Oakland replaces **Walter H. Wehner**, on leave with the Army. **John R. Schmank**, area manager for TAL's express-mail-freight department, is on leave with the Navy. TWA's board of directors elected to the board **V. E. Conroy**, vice president in charge of traffic, and **John K. Gallinger**, vice president of operations. **John M. Lockhart**, assistant secretary and assistant treasurer, assumes the duties of secretary-treasurer. **J. C. Franklin**, superintendent of engineering, has been named vice president in charge of engineering. **Arthur M. Jens, Jr.**, joins TWA as assistant to the treasurer. **C. L. Gale**, manager of tariffs, schedules and research, has been appointed assistant to Mr. Conroy. **R. E. Whitmer**, system transportation manager, succeeds Gale as head of research, and **C. E. Bartholomew** moves up to system reservations manager. **Don W. Heap**, district traffic manager at Amarillo, is appointed assistant system reservations manager and **Ray A. Bloker**, traffic representative at L. A., succeeds Heap.

Gunner Edenquist, former sales manager, has been elected vice-president and assistant to the general manager, and **Walter C. Mikel**, former production manager, has been elected vice-president in charge of production of Kinner Motors, Inc.

Neal Wood was appointed to the newly created post of plant superintendent of Northwest Airlines and will have charge of procurement and maintenance of the line's physical property and allocation of work space.

A. C. Galbraith was appointed manager of employe' counseling for all Douglas plants. He is former Union Oil vice-president.

Archibald Black was appointed chief draftsman of Simmonds Aerocessories.

Leslie H. Bowman was elected president of the National Aviation Trading Assn. succeeding **William A. Ong**, retiring president. **Col. Roscoe Turner** was named 1st vice-president and **F. Leslie Meraden** succeeds him as 2nd vice-president.

Brig. Gen. Jacob Davies, Commandant of the Midland Army Air Forces Bombardier School, has been named commanding General of the newly activated 24th flying training wing.

Albert Kahn Associated Architects & Engineers announces the election of three new vice presidents: **Sheldon Marsden, George H. Michle** and **Robert E. Linton**. **George K. Scrymgeour** was elected secretary and **Saul Sanlson** is the new treasurer.

Reginald L. Gallpeau has been appointed superintendent of maintenance at Georgia Aero Tech.

George L. Findley was promoted to director of public relations at Boeing Aircraft's Kansas plant and **Lee W. Mulloy**, editor of the plant's house organ *Courier*, to the new assistant public relations director.

J. A. Williams, for the past two years general manager of Curtiss-Wright's Ohio plant, returns to New York State to join the Airplane Division's staff for Military Contracts, Subcontracts and Licensing.

Piper Aircraft announces the following promotions: **Hansford E. Eckman** to plant manager; **Findley A. Estlick** to general plant superintendent, **Richard C. Garber** assistant plant superintendent.

Roy Grant, L. A. steamship and air traffic expert, is appointed assistant to **Thomas Wolfe**, vice-president of Western Air Lines in charge of traffic and advertising.

Maj. Gen. Walter A. Detamaler is elected a director of Dowty Equipment Corp.

J. A. Ireland is named assistant general manager of sales of Steel & Tubes div. of Republic Steel, and **I. H. Anderson** is new district manager of sales.

R. E. Hoeflin, re-elected treasurer of Waco, is also named one of the two new directors added to the expanded board.

Cheriee "Buddy" Wolf and **Harold Gray**, of Ranger Aircraft Engines, won first place for their production short cut. **Maurice Bellenger** placed second and third prize went to **John Moissel**.

Gus N. Arneson, former research chief for the Douglas Fir Plywood Assn., has been selected by the U. S. Forest Products Laboratory to become principal technologist.

Raymond E. Peterson, TAL, has been appointed assistant to R. F. Ahrens, personnel director. **Hal Furman** succeeds him in handling selective matters for the company's personnel department.

J. Wesley Cable, research and development engineer of Induction Heating Corp., has assumed the added responsibilities of general sales manager.

1943 Goal Now 108,000 Airplanes; Engines Running Ahead; Obstacles Cited

WASHINGTON (Aviation Bureau)—Based on numerical output, the airplane production program for 1943 (unofficial, unpublished, but accurate) is now put at 125 percent of the '42 production. Last year's total having been revised to round figures of 48,000, this means that some 108,000 aircraft are called for in '43.

Meanwhile, the President's announced 5,500-plane output for December has been officially calculated at 5,489, inclusive of a considerable number of craft delivered to the 'pool' (received by procurement officers but not flown away) minus propellers, wheels, instruments, or other parts. By early January, the number of planes in the pool was back to normal. Sometimes the pool accumulates planes simply because bad weather prevents their being flown out.

Apparently Army, Navy and WPB have agreed to publish the monthly production figures on planes from now on. Figures include those delivered to Army, Navy and the Allies, whether by sale or lend-lease. It is noted that in December, production of combat planes, measured in dollars, increased 16 percent, transport and observation rose 25 percent, and the "up" in training craft was 32 percent.

However, Mr. Nelson (as well as other officials) has said that an unbalanced phase of aircraft production is the output of engines, which is now running ahead of planes. At some points, says Nelson's report, storage space for engines is becoming a real problem. Steps are being taken, meantime, to divert metal from engines to airframes and parts. For several months aluminum and alloy steel forgings and aluminum extrusions and shapes have comprised a bad bottleneck, and still do.

Tightness in materials, in general, is in partially fabricated items, there is enough ingot, both of steel and aluminum. Flow of government furnished equipment (gfe) is more satisfactory than manufacturer furnished equipment (mfe).

Returning to the high-reaching 108,000-plane program for 1943, it is to be noted that the materials problem is expected to get worse before it gets better. In terms of tonnage, much more than a 125 percent increase is involved, since models scheduled for this year are heavier, making the materials and fabrications job even more difficult than it would first appear. In fact, it is so difficult that some high officials doubt if the industry will be able to meet the 1943 bogey.

Even if it falls short, however, it will still be excellent, both from the point of view of the production man and the military man.

Another problem growing more serious day by day is absenteeism. The very top men are worrying about it, including C. E. Wilson and Maj. Gen. William Knudsen. The trouble is worse on the West Coast than elsewhere, officials say. They find that inexperience and lack of discipline are the main cause, and not much can be done about it. But efforts are being made to keep stores open at night, to offer prizes for good attendance, and to provide amusements. It has been found that some workers take to drink through sheer boredom.

Still another difficulty that will stand between the industry and its goal is the constant and increasing stream of change orders to meet the needs of front line commands. This problem has been partially met by the increased use of modification centers. But these centers themselves are taking men away from the production lines, since some models are requiring thousands of hours in changes per unit. Then too there will be several changes to entirely new airplane models this year, which will slow down the show.

The aircraft program is assuming ever greater proportions. It is now estimated to be roughly 40 percent of the entire armament program in terms of dollars and that figure might be revised upward some time this year. It is now an open secret everywhere in war production camps that man-hours, materials and facilities are being diverted from canceled orders for tanks, anti-aircraft guns, trucks, and some types of mobile artillery, to aircraft channels. Conversion of the Mack Truck plant to Vultee torpedo bombers is just one example of a increasing trend.

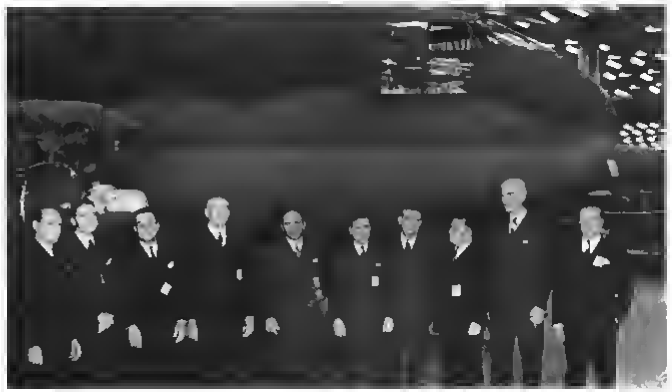
Leveling off of the construction of plants is rapidly cutting down the machine tool industry's backlog of orders, and soon some of the machine tool plants may be available for the production of ordnance and component parts for aircraft. Superchargers and propeller assemblies already have been considered for production by machine tool builders. The tool builders first would have to retool themselves, a process it is said, that would take some time. Furthermore, the whole theory may be wrong, for some observers believe that the increasing loss of skilled men may cut down the hours per machine in both machine tool and ordnance plants, and that it may eventually result in a continued call for machine tools at current rates of production.

Outline New Program For Aero Chamber

Washington (Aviation Bureau) — Following several months in which the future of the Aeronautical Chamber of Commerce was in doubt, a plan for its reorganization has just been presented by a committee set up for this purpose and headed by E. N. Gott of Consolidated. The "subject to change" program presented by the committee includes the following main points:

Assessments against each member for the fiscal year ending Oct. 31, 1943, shall not exceed 25 percent of the amount assessed against that member in the fiscal year 1942.

Budget for the period Mar.



AWPC'ERS VIEW "COMMANDO"

C-46 "Commando" transport is inspected by members of Aircraft War Production Council of East Coast during recent visit to New York plant of Curtiss-Wright Airplane Division. Left to right are C. A. Van Dusen, of Brewster; Ralph S. Damon, Republic; Guy W. Vaughan, president of Curtiss-Wright and retiring president of War Production Council; Glenn L. Martin, incoming council president; Victor Emanuel, Aviation Corp.; L. C. Goad, Eastern Aircraft Division, General Motors; Burdette S. Wright, vice president in charge of Curtiss-Wright Airplane Division; Larry Bell, president of Bell Aircraft; J. Carlton Ward, Jr., president of Fairchild Engine & Aircraft and new council vice-president, and J. S. Randall, general manager of the council.

1, 1943 to Oct. 31 1943 shall not exceed two-thirds of the amount realized from such assessment

To expedite decisions and action the membership of the Board of Governors shall be reduced from 32 to 15 with one member from light plane manufacturers one from manufacturers of engines and/or accessories four members from airframe manufacturers (not light) from east of the Mississippi, and five members from airframe manufacturers (not light) from west of the Mississippi.

The Board of Governors is empowered to delegate certain responsibilities to an executive committee consisting of not less than five, all members of the board. There is to be a president, a vice-president secretary and treasurer all to be elected semi-annually Routine operations are to be conducted by a manager and staff assistants Activities are not to include publicity or advertising and shall not duplicate or conflict with either of the aircraft war production councils

SONJ Opens High Test Gasoline Plant

Supplies of high octane gasoline for Allied air forces, and for lower weight-power ratios in aviation and automotive engines after the war, are being augmented by the development of catalytic cracking plants Transportation of fuel to fighting fronts is a problem fully as serious as that of production

Standard Oil of New Jersey recently opened its third "cat cracker", and is opening two more in Texas and Louisiana The oil industry has 25 plants in its program over and above those of SONJ

At ceremonies opening the New Jersey plant, officials stated that United States fuel rating is far ahead of that of the enemy, but other reports say that samples taken from captured German planes show their fuel is as good as ours Germany is supposed to get more power from low-rated fuel than we do by using fuel injection but this, too, is controversial

Cite Portable Runways

Portable steel runways for emergency airplane landing fields have demonstrated their effectiveness in North Africa, the Southwest Pacific and in other combat zones occupied by American troops, says the War Department

By laying these mats of prefabricated steel grids longitudinally and in two directions at once, starting from the center it is possible to provide a field 150 by 3 000 ft in less than 48 hr exclusive of grading or other preparations

Although the light types are designed for pursuit and observation planes and the heavy types for bombers, soil conditions encountered sometimes make it necessary to reverse this use.

Wood Parts Save 200lb. Of Aluminum per B-24

Substitution of plasticized wood is saving more than 200 lb. of aluminum alloys per B-24 bomber, Consolidated Aircraft Corp announces Substitutions the result of more than two years of research include development by the company of its own baking processes

More than 30 parts now made of metals and used in the PB2Y3 *Coronado* flying boats are to be replaced by plasticized wood in the near future Replacements in the B-24 cargo plane are also in production

Included in the B-24 bomber and cargo changes are wing tips of plasticized wood parts trimming tabs, push-pull and control cable guards, escape hatch side gunner doors and boxes and map cases Projected for the model are nose wheel doors and wheel well domes. The wood parts are being subcontracted.

Hydraulics Group Meets

Use of paper filters in aircraft hydraulic systems was recognized at a recent two-day session of the Subcommittee on Hydraulics of the National Aircraft Standards Committee held at the Muehlebach Hotel, Kansas City Also discussed were standardization of tube fitting materials and dimensions and seals and cylinder specifications

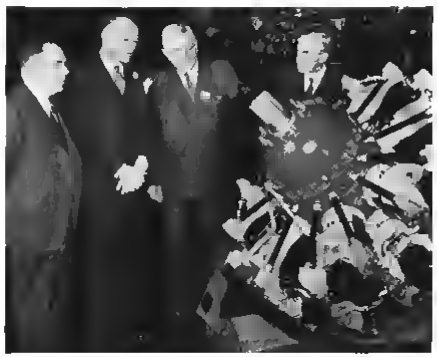
Harry P Kupiec, hydraulics design engineer for the Glenn L Martin Co. and national chairman of the subcommittee recounted cold weather operational problems he observed on a recent trip to Alaska Among those present were Howard Field Jr, North American Aviation, B R Teree Curtiss-Wright, George Rix Aircraft Accessories, and Jules Kovacs, Purolator Products.

Consolidated and Vultee Directors Okey Merger

What would result in one of the largest aircraft manufacturing enterprises in the world is in the offing with the proposed merger of Consolidated and Vultee Aircraft under the name of Consolidated-Vultee Aircraft Corp

This merger plan has been under consideration since Vultee acquired 34 percent of Consolidated's outstanding stock at the end of 1941 Maximum wartime efficiency is given as the reason for wanting the proposed merger

Tom M Girdler, chairman of Consolidated and Vultee, has announced approval by the directors of both companies who are recommending the merger to the stockholders of their respective companies at annual meetings on March 17



LAUDS BUICK ENGINE OUTPUT

"Fabulous progress has been made by your production of more engines for Army bombers in one year than original schedule called for in two" reported C. E. Wilson, president of General Motors, to employees of Buick Illinois plant during recent inspection visit. Mr. Wilson (third from left) views one of completed power plants With him (l. to r.) are Harry Golden, resident engineer, D E Williams, operating manager, and J. G. Hammond, manufacturing manager

Under the terms of the proposal to be voted on by stockholders each share of Vultee common stock will be exchanged for 45/100th share of the new Consolidated-Vultee common stock Consolidated's present common stock will be exchanged share for share for common of Consolidated-Vultee. Vultee's outstanding $1 25 cumulative preferred stock will be exchanged share for share for new preferred stock, convertible into 1¼th shares of new common stock.

Two Contracts Increased

Douglas Aircraft and Liberty Aircraft have received contract increases from the Defense Plant Corp Liberty was awarded $180 000 in addition to a previous $1 980 000 to expand its facilities in New York. Douglas received $1 565 000 also for facilities expansion resulting in the extension of its over-all commitment to approximately $10 600 000 Both new plants will be operated by the contracting firms but titles will remain with the DPC

New Synthetic Diaphragm

Perfection of Goodyear's synthetic rubber Chemigum for use in accumulators of aircraft hydraulic systems has been announced by P. W. Litchfield, chairman of firm's board of directors. Goodyear engineers have found that the synthetic is unaffected by hydraulic fluids and can therefore be employed in accumulator diaphragms

Aluminum Scrap Plant

In the Detroit area, Bohn Aluminum & Brass Corp has put into operation a new plant for refining of aluminum scrap into alloy ingots. Ernest Bell has been appointed manager of the plant which Bohn has named the Aluminum Refiners Division

Navy Signs Contracts For New Aircraft

Two West Coast manufacturers report completion of contract arrangements which will add a new land plane and a new flying boat to the Navy's flying equipment The land plane is North American's B-25 *Mitchell* Bomber specially fitted for off-shore patrol It will be known as PBJ-1 The flying boat, designated P4Y by the Navy, is the Consolidated Aircraft Corp.'s twin-engine model 31 prototype of which was first launched in May, 1939

Described by Navy officials as the fastest flying boat ever built in America if not the world the new seaplane has been redesigned to include the latest combat developments and will be used for both fighting and cargo duty. It will be produced in quantity by Consolidated at the Louisiana factory originally assigned to Nash-Kelvinator for construction of cargo planes

Tooling of the plant is in progress and production of the P4Y is expected to get under way shortly, according to I M. Laddon, Consolidated executive vice-resident and general manager

West Coast Plants Set Up Safety Plan

Member plants of the Aircraft War Production Council, Inc have put into operation a plan designed to reduce the already small accident rate on aircraft production lines.

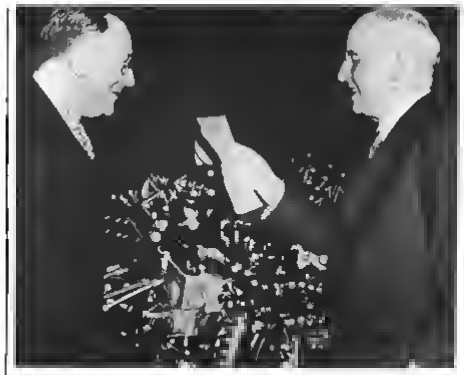
The Council comprised of Consolidated, Douglas, Lockheed North American, Northrop, Ryan, Vega and Vultee, made the announcement simultaneously with the first two exchanges of safety data between the companies under the new plan

Under this plan each company will prepare brief outlines describing safety methods developed in its plant This information will then be passed along to other member companies and to other manufacturers.

As an example the first exchange of this safety data to go out under the new system covered operation of a "goggle cart" of the Vega Aircraft Corp Equipped with new goggles sterilizing equipment and tools for adjustment of goggles the cart tours the plant regularly On these tours the cart attendant helps keep eye safeguards in condition to give maximum protection. Furnished with detailed information about the Vega system other companies are planning its possible installation

Second safety information to be exchanged was contributed by Northrop Aircraft, Inc. where a plan has been worked out to reduce accidents on heavy duty machines Operators are rotated four times per shift in order to avoid simple fatigue from repetitive work Thus the operator is always fresh and remains aware of the dangers of the machinery

Information regarding these safety devices is available through the Council to other war industries



. . . AND MORE ON WAY

Packard Board Chairman Alvan Macauley (right) and George T. Christopher, president and general manager, read cable from RAF Wing Comdr. L. S. Lee describing performance of company's Rolls Royce engines on fighting fronts. Comdr. Lee piloted first Packard powered "Lancaster" to participate in recent raid on Berlin, later led "Lancaster" daylight attack against Le Creusot France

L. A. Sub-Contracting Up

Conversion of small industrial plants in Los Angeles County, Calif., to aircraft subcontracting averaged 49 a month during 1942 according to figures compiled by the aviation department of the Los Angeles Chamber of Commerce Sub-contractors supplying the major aircraft companies with accessories, parts, materials and machinery jumped from 275 to 366 during the year

Assembly Lines

Cause and cure of flutter is being studied by McDonnell Aircraft The Missouri company uses a technique stated to be 'new to aviation' for observing and measuring the motion of a plane wing during flutter under controlled conditions simulating flight with varying load distributions and speeds It is hoped that flutter characteristics of new wing designs may be analyzed and accurately predicted prior to construction of the plane

A 15-ton flywheel is part of a device used by Goodyear to check upon heavy duty airplane tires in a test simulating bomber takeoffs and landings The tire is forced against the 15-ton wheel under 15 000 lb pressure, or about half the load which one tire would bear in a normal landing A Goodyear airplane brake is also tested by means of the wheel and the tire together

Two propellers, one regular Hamilton Standard "original" and one of the same design by Nash-Kelvinator, recently were disassembled and the parts were scrambled—then two "mixed" propellers were re-assembled The resulting props balanced perfectly showing the complete interchangeability of the propeller parts manufactured by the two companies—of great importance in maintenance at the front. Buick and Pratt & Whitney likewise scrambled a couple of engines some months back, with the same results Incidentally — and many great projects are just incidents these days—Nash-Kelvinator has started mass production of P & W 2 000 hp high altitude engines Company says just one of these engines has as much power as about 30 Nash '600' auto engines

Excepted from price control are special services of private contractors in modifying certain aircraft for the Army and Navy, says OPA Exemption is Amendment No 16 to Supplementary Regulation No 4 to the General Maximum Price Regulation and it applies to work done in modification centers More than 3 000 combat planes have been "tailored," after leaving factory production lines to fit them for specific fronts and to incorporate improvements requested by various front commanders Some of these modifications take 'thousands' of hours per plane

Flexible engine mounts for training planes have been developed by Goodyear. Engineers say the new mountings will cut vibration and extend the life of the planes Quantity production is expected soon Tests also are being made on large-engine types of mounts.

Green polaroid isinglass panels are installed by Chicago and Southern Air Lines in training planes for instrument training, thus doing away with the black hood The student wears red-lens goggles which cut out 50 percent of the spectrum, and meanwhile he can't see through the green panels which cut out the other 50 percent Thus he has vision of everything inside the cabin but nothing outside. The instructor, who wears no goggles, can see everything outside at 100 percent efficiency

Eight months training for women in aeronautical engineering at the Daniel Guggenheim School of Aeronautics, New York University, under scholarships established by Vought-Sikorsky Div. United Aircraft is announced. The scholarships, named for Chance M. Vought, provide tuition, room, board, and $50 a month Engineering drawing, descriptive geometry mathematics and aerodynamics mechanics, stresses, weight analysis and other subjects are included

If you work for Cessna, you can tell the boss to his face if you feel like it, or with "complete anonymity." If you prefer—and nothing will happen except perhaps he will do as you say. The company has given out a questionnaire containing 55 inquiries and space for comment on policy, tools the credit union group insurance and everything else, including the music played over the public address system Employees have been asked to fill out the paper as a favor to the company.

A super-hard rivet, called the 'Hi-shear' strong enough to replace bolts on aircraft or other structures, has been developed by North American. The new rivet, stated to be 60 percent lighter than equivalent bolts and rivets, is reported particularly valuable in a combat airplane design such as the P-51 *Mustang* fighter to lighten weight of the wing The rivets are available to other war concerns

NOTHING MECHANICAL IS IMPOSSIBLE

That's a challenging statement, but our experience has proved it true. We've tackled jobs which some experts had declared impossible yet we accomplished the desired results... jobs involving single mechanical parts and also complete assemblies. We did the impossible.

Long before Pearl Harbor we amazed many manufacturers by reducing the number of parts in their assemblies; doing tooling which made inventors' dreams realities; straightened out and speeded production through ingenuity.

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Would Amend Civil Aeronautics Act Preparatory to Postwar Operation

WASHINGTON (AVIATION Bureau)—For the first time in its four-year history, the Civil Aeronautics Authority is asking that the Civil Aeronautics Act of 1938 be amended. A bill has been written for CAA by Rep Clarence Lea of California, and at this writing was in hearing before the House Interstate and Foreign Commerce Committee. There was no opposition, and passage in some form seemed assured.

Since the beginning problems like multiple taxation of airlines by states, lack of authority to control 600 local airport zoning requirements and lack of clear demarcation between interstate and intrastate commerce have been accumulating. These and other matters are provided for in the Lea-Bailey bill. (Sen Josiah Bailey introduced an identical bill in the Senate.)

There is however more than a collection of vexations behind this move for a revised law. The world airway system now under control of the United States is far bigger than, and almost completely out of the control of, the Civil Aeronautics Act and its administrators CAB and CAA today are extensively the instruments of the Army and Navy.

When the war ends weighty problems of defense of foreign commerce of immigration and all that international relations implies will hinge upon our aviation policy and our administration of it. The Civil Aeronautics Authority (Board and Administration) needs the power to begin its work now, for if the CAA does not have the power its officials know that some super authority will be set up to take over.

Aviation will be a matter of Cabinet proportions and some observers believe that this build-up of power can only culminate in the creation of an Aviation Department, as well it might.

In detail the bill: Would make the civil air system definitely a military aviation auxiliary; require the board to report to Congress in one year upon carriage of classes of mail by air where delivery would be speeded; give CAB control over foreign passenger and express rates, put air forwarding under CAB control; authorize CAB to issue a permit to a foreign carrier without a hearing if the case is covered by an international agreement; make CPT a permanent institution; make all air traffic interstate commerce; require the Administrator to maintain a comprehensive port and facilities program; give the Administrator power to zone local port areas; make CAB responsible for air service to all United States possessions and places in which we are interested; prohibit multiple taxation of airlines, and bring charter operators under the head of contractors.

Three Petitions Denied

One certificate of public convenience and necessity was granted and three petitions were denied in recent decisions of the CAB. Chicago & Southern Air Lines was authorized to make Little Rock, Ark., an intermediate stop on one of its routes. The following petitions were denied: Waterman Airlines to intervene in Pan American's application for an amendment to its certificate covering the Miami-South America route; TWA for reconsideration of Continental Air Lines' certificate on the Denver-Kansas City route; the Postmaster General for reconsideration on mail pay to Pennsylvania-Central Airlines.

CAB Clears Airline Pilot

Washington (AVIATION Bureau)—Charles Pedley, American Airlines pilot who, with his crew and passengers was killed last fall in a collision with an ATC bomber, was completely exonerated by the Civil Aeronautics Board. It was recalled that earlier an Army court martial cleared the bomber pilot.

In its report the board declared that testimony of Pvt. Roy West, one of three known eyewitnesses "cannot be considered reliable" because 'he was a stranger to aviation." His testimony did not agree with that of Mrs. Margaret Caldwell and Raymond W. Marlin, the latter a volunteer airplane spotter.

"The pilot of the bomber testified with great frankness to the facts which showed that he diverged from his military mission to fly the bomber in close proximity to the airliner for the express purpose of signalling a friend in the co-pilot's seat of the latter plane.' the board's report stated, adding that "we are driven to the conclusion that this collision resulted from the reckless and irresponsible act of the bomber pilot and that the captain of the airliner was without fault."

British Combine Photo

ARMS IN A HURRY

Some indication of part transport planes are playing in Allied successes in New Guinea is offered in these photos of "heavy supplies on a hurry." Above: Lt. Gen. George Kenney (extreme right), commander of Allied air forces in Southwest Pacific, supervises shipment of a 105-mm. howitzer. Below: Australians unload a bulldozer.

FDR Names Policy Board

Washington (AVIATION Bureau)—The interdepartmental committee set-up by President Roosevelt to study postwar airline policies (see AVIATION News, Feb., 1943) is headed by Adolph A. Berle, Assistant Secretary of State.

Members include Robert A. Lovett, Assistant Secretary of War for Air; Artemus L. Gates, Assistant Secretary of Navy for Air; Wayne Chatfield Taylor, Undersecretary of Commerce, and L. Welch Pogue, Civil Aeronautics Authority chairman. Wayne Coy, Director of the Office of Emergency Management and Harry L. Hopkins, both advisers to the President, are serving as advisers to the committee.

Western Applications Get Preliminary Approval

Western Air Lines application for a new route from San Diego to El Centro, Calif., and Phoenix, Ariz., has been recommended by a CAB trial examiner. reports Leo H. Dwerikotte, executive vice-president. The company plans to increase its service between Los Angeles and San Diego to eight flights daily if final approval is granted. The new route will provide direct connections at Phoenix for

San Diego and the Imperial Valley Western has also been recommended for Los Angeles-San Francisco operation. Final permission has not been given on this route.

Pres. William A. Coulter announces that the company's 1942 operations shattered all previous years' figures with approximately 25,000,000 passenger revenue miles flown, together with 567,032,833 express and 632,387,080 air mail pound-miles. Compared with the preceding year, 1942 figures show a 67 percent increase in passenger miles, 15.74 percent in air mail, and 100.93 percent in express. Meanwhile the line's personnel expanded 66½ percent, with the percentage of women employees up from 16 to 30.

Panagra Cargo Extension

With beginning of service linking Lima, Santiago and Buenos Aires, Pan American Grace Airways is now operating one of the longest all-cargo services in the world. Last August Panagra inaugurated a 1,675-mi. run from the Canal Zone to Lima, operating DC-2s with average payloads of 3,300 lb. The new leg adds another 3,600 mi. to the initial route.

New Airport-Work Ban

Construction work on 15 airports in addition to the 22 already halted (AVIATION, Feb., p. 361) has been ordered by WPB. Total cost of 17 of them was estimated at $9,433,235. Projects affected by this latest directive are located in Willimantic, Conn., Tarpon Springs, Fla., Twin Springs, Idaho, Peoria, Ill., Princeton, Me., Hatfiesburg, Miss., Whitefield, N. H., Bendix and Highstown, N. J., East Hampton, N. Y., Alva, Okla., Longview and Uvalde, Tex., and Parksley, Va. Some work will be continued at fields at Easton, Md., Athol-Orange and Hyannis, Mass., Allentown-Bethlehem, Pa., and Bradford-Kane, Pa.

Radio Power Increased

Radio power of Western Air Lines transmitters at Las Vegas, Nev., Salt Lake City, Utah, Great Falls, Mont., and Burbank, Calif., has been increased ten-fold with the completion of a $150,000 radio modernization program, just announced. Last unit completed is a new 3,000-watt transmitter at Burbank, just placed in service. Included in the program are both aircraft and ground devices and laboratory testing equipment.

Airline Shorts

Chicago & Southern announces daily service to Little Rock, Ark., effective Mar. 1. . . . A survey by the CAB (covering Sept. 24-Oct. 21) indicated TWA's New York-Chicago-Los Angeles run is the most heavily trafficked with the Pittsburgh-Chicago leg attaining the high average of 64.4 percent payload. . . . New international airline will be a San Antonio-to-Laredo, Mexico, Braniff extension recently okay'd by the Civil Aeronautics Board.

HONOR FOR PAN AMERICAN

"For pioneer service insuring utmost safety in overseas flight," PAA was awarded the 1942 Arthur Williams Memorial Medal, presented annually by American Museum of Safety. Juan T. Trippe (right) accepts medal from CAA Chairman Welsh Pogue at dinner at Metropolitan Club, Washington.

Postwar Planners Turn Spotlight On Question of "Freedom of Air"

When things go better for the United Nations, postwar plans are dug up again and widely discussed—some of which are of a nature which may vitally affect the future of the airlines now covering the globe. One item which has been put in the spotlight, not only in the House of Commons in England but also in domestic newspapers and magazines, is the pertinent question of "Freedom of the Air."

In itself, this idea is not new. As far back as 1934, the pioneer Plesman, then managing director of the Royal Dutch Airlines, made a rather widely quoted speech in Copenhagen in which he discussed this question. And during the years that followed—especially at the yearly meetings of the International Air Traffic Association, to which our Pan American Airways also belonged—the idea was kicked about rather considerably. Then little Holland, generally in the forefront with new plans for air transport, suggested that she might be the first to adopt this policy, provided the other nations followed suit.

At the last IATA meeting held in 1939, indications were that most European members would adopt the Freedom-of-the-Air slogan, but war interfered rather rudely, and the whole thing was shelved.

Basically, Freedom of the Air is as simple as Freedom of the Seas, for which many wars have been fought. It would provide for free passage of all aircraft over the airways of all countries, plus docking or landing facilities at airports of their own choosing upon payment of the necessary landing fees.

As a postwar item, though, it is rather a ticklish subject, and actually should not be definitely settled without full and complete understanding of all countries concerned. The problem becomes a virtual powder keg, especially where we may again have to compete with subsidized airlines, which are in a position to provide better equipment than competitor companies which are in the business for economic reasons and not national prestige.

The British, especially, are getting worried about the prospects of their postwar air routes—after being forced by war circumstances to place most of the transport duties in the hands of American companies or the United States Government itself. And already being short of transport aircraft for their own immediate pressing needs, they are beginning to feel a little like orphans and certainly do not wish to be kept in that position when the war ends.

To them, this Freedom of the Air is all right, provided all have an equal chance at the start. This equal chance, from all indications, will only be there if this country concentrates sufficiently on the building of transport aircraft to satisfy the immediate needs of the reborn airlines, and then assists these airlines, possibly by pooling arrangements, to get on their feet again.

Nazis Dissect "Spitfire" —And Admit It's Good

General tone of a German report on the *Spitfire IX*, an example of which apparently landed in their laps more or less intact, is none too happy. They class its maneuverability as "excellent" and say the aerodynamic details are "rather good"—which is a lot coming from them. According to reports published in magazines getting through to England, the plane has a top speed of 370 to 380 m.p.h., since they "doubt" whether the plane would go much faster. And the ceiling is said to be between 36,000 and 39,000 ft.

This information is in direct contrast with news that *Spitfires* have gone up to 50,000 ft. over the Egyptian desert to shoot down the new German Ju-86P's, which had been making reconnaissance flights at that altitude. It has further been indicated that the *Spitfire IX* has a top speed of over 400 m.p.h. which, considering the facts that it mounts the new Rolls-Royce *Merlin LXI* engine with high supercharging and intercooling, appears about right. Together with the *Thunderbolt*, *Mosquito*, and *Lightning*, the *Spitfire IX* has taken its place in the Allies' new class of 400-m.p.h.—plus high altitude planes.

Allies Make Check On Captured "Stukas"

Several intact models of the Ju-87D, latest model of the famed (or infamous) *Stuka* divebomber, have been captured during the African campaign. Amazingly enough, the plane still has the original type engine and armament, and can only be used when air superiority over the target has been established—which does not happen very often any more.

It is rather curious that the Nazis are trailing every nation in the world in the development of better dive bombers—or could it be that they feel that the need for more fighter protection against the joint British American raids is more pressing? This seems to be borne out by the new Me-115, which has been seen off and on along the Eastern front and also occasionally over Western Europe.

Very evidently an answer to new Allied types this plane is equipped with an X-type engine consisting of two 1,100-hp. DB-601's apparently designated DB-606. Complete lack of mention of this plane in German notices, usually fast in calling anything and everything German the best and fastest in the world, seems to confirm the *Aeroplane's* viewpoint that the plane is still far from satisfactory and that the Nazis prefer to keep its failure quiet.

Re. That "Seafire"

Many pictures but no details have been released to date of the new British *Seafire*, oceangoing version of the famed *Spitfire*. All data indicate that this plane is now available in considerable numbers for all current British carriers and that it has seen action in the African operations and during other convoy duties. Design and construction of a plane of this type parallels American experience, which indicated the urgent need for faster and more heavily armed fighters based on carriers, especially where the ever increasing ranges of landbased aircraft make these floating landing fields subject to attack by planes with superior speeds and ceilings.

America has developed the *Corsair*, now apparently coming into production on a large scale, as the answer to these problems, and will soon be in a position to equal or even surpass British carrier based aircraft as far as armament and performance is concerned.

Canadian News

By JAMES MONTAGNES

Canada's aircraft industry, born practically out of the war, was told recently by Ralph P. Bell, director-general of aircraft production for the Dominion, that "the aircraft

ON WAY TO WORK

British airmen have been smearing Germany for some time with a new "parachute" bomb which detonates with great lateral, rather than subterranean, pressure. Here, in one of first pictures of new weapon, a "Hampden" bomber, once considered obsolete, takes on chute-bomb cargo at dispersal point of an RAF station.

industry of Canada has a tremendous postwar future as long as you in the industry can get costs down to a level competitive with the rest of the world. You will have to hammer down costs until the price of Canadian-built planes will be lower than those built anywhere else in the world." During 1942 the Canadian industry increased its production 2½ times over that of 1941, 5 times that of 1940. Since June 1940 the Canadian companies have produced 6 500 aircraft, with about four-fifths remaining in Canada. Present orders include half the production for use in Canada, the rest for use in Great Britain and the United States, these export planes being nearly all combat type aircraft. Planes built last year cost $235,000,000 in 1941 cost $102,000,000, and in 1939-40 cost $42,000 000.

Air express carried by the publicly-owned Trans-Canada Airlines during 1942 increased 128 percent to 396 000 lb., mail increased 83 percent to 2 280 000 lb., and passengers carried were 106 000 an increase of 24 percent, according to a year-end statement of H. J. Symington, president of TCA at Montreal. TCA now flies 22 790 mi. a day over a route of 4 257 mi. The largest proportion of this is war business. During the year, service was extended to Newfoundland and additional flights were made between Canadian cities to take care of war traffic. "In 1943 the TCA route will be extended from Vancouver to Victoria, B. C.," said Mr. Symington. "When the war is over and new equipment is available, TCA will take an important part in the development of global aviation. We have plans for a shorter route across the continent, crossing the Great Lakes to Winnipeg, and thence to points of exit in western Canada and the Yukon Territory. Canada occupies an important position in the future of the air world."

Number of workers in the aircraft industry has jumped from 1 000 when the Dominion went to war in Sept. 1939, to about 75 000 at end of 1942. Women workers now total nearly 30 percent of all aircraft employees. Of the total 20 000 are in the repair and overhaul industry, a brand new war-built industry.

Nine types of planes are now being built in the Dominion. The Fairchild *Cornell* trainer, the North American *Harvard* advanced trainer, the *Anson* and *Bolingbroke* twin-engined bomber trainers, *Hurricane* fighter, *Mosquito* twin-engined reconnaissance bomber, *Catalina* twin-engined flying boat, *Lancaster* four-engined bombers and Curtiss *Helldiver* bomber. In the past year the industry has cut corners on costs and found new methods of construction simplification including the *Anson* gasoline tank cover made of plywood instead of aluminum, seats of plywood instead of aluminum, seat cushions filled with curled hair instead of being made of rubber, wireless masts made of laminated wood instead of steel tubing, identification labels now made as decalcomania transfers—and many other similar material, cost, and labor saving simplifications.

STILL MORE POWER

W. Elliott (kneeling), designer of the "Merlin 61" explains its two-stage supercharging mechanism to British Air Commodore McEntegart. New engine is being used in "Spitfire IX." Exact horsepower is still secret, but it is announced that improved supercharger increases power output 50 percent.

On Schedule . . . by "Vista"

Little publicized but still important in the general shape of air transportation in Europe is the weekly airmail service between Stockholm and England, which has been in operation for over a year. The Swedish A.B. Aerotransport has done a remarkable job during this war in keeping most of its airlines going, maintaining connections with both sides. Unfortunately, news has been rather sparse during the past months about the ABA, but in general most lines reported previously are still being operated, including a new projected connection with Lisbon now that the German airlines have come to a virtual standstill through the Russian debacle.

Iceland appears to be due to come into the news as one of the major ferrying bases very shortly. Lying about 2,500 mi. from New York and about 1 500 from Newfoundland, it appears destined to become a major commercial base after the war. It is not generally known that KLM Royal Dutch Airlines had planned commercial service to Iceland in 1938 and 1939 and that a Dutch military mission made extensive aerial weather surveys during the early '30s. Much of the KLM's data was closely tied up with the results reported by members of the survey party, and it was hoped that eventually the expansion of the Botwood base would enable KLM to establish its long hoped for North Atlantic line.

Same people have been viewing the increase in accidents of Air Transport Command aircraft as an indication that international air commerce is still far from reaching a practical salution. Washington has indicated on several occasions that 99.8 percent of all planes ferried or flying under ATC orders go through on schedule, and it is therefore logical to assume that the slight increase in accidents is due to two factors—first, that frequency of flights has multiplied by leaps and bounds, and second, that many of the routes are continued in all weather conditions, since war demands such action. Use of larger aircraft may bring larger number of casualties in isolated mishaps. But there is an increasing safety factor for the ATC which will tend to reduce accidents to a minimum.

British RR Airlines

Three English railways, the London, Midland & Scottish, Great Western, and Southern Railway, have recently acquired control of British and Foreign Aviation, Ltd., a holding company for several of the smaller British feeder airlines.

These lines mostly unknown in this country, consist of Great Western and South Airways, Isle of Man Air Services, West Coast Airways, Olley Air Service, and Air Commerce, Ltd.

"Kurier" Non Transport

With the menace of the FW-200 *Kurier* virtually eliminated by use of catapulted *Hurricanes* on convoy escort ships the Russians report that these FW's are now being pressed into service as transports on the Eastern front. It is interesting that in stark contrast with this country Germany has only brought out one new type transport in 3½ years of war, namely the BV-222 six-engined flying boat, mentioned in a previous issue of AVIATION.

Further French Plans

The French claim that they are still building new aircraft for their proposed "commercial" airlines. Next to their superplanes, one or two of which are actually flying, the SNCA is now said to be building the SO30N—a copy of the CW-20 as far as size capacity and speed is concerned even to the figure-eight fuselage and twin-row engines. Just what use these aircraft will be in occupied France is a mystery to most persons.

Merger of Consolidated Aircraft Corp. and Vultee Aircraft, Inc., creating one of the largest aircraft manufacturing concerns in the world, is proposed in recommendations approved by directors of both companies for submission to stockholders March 17. As announced in this column two months ago, the merger has been under consideration since Vultee acquired 34 percent of Consolidated's outstanding stock. The new company will be called Consolidated Vultee Aircraft Corp. Under the proposed terms of the merger, each share of Vultee common stock will be exchanged for 45/100th share of stock in the new company, while Consolidated's common stock will be exchanged on a share for share basis. Vultee's preferred shares also will be exchanged share-for-share into the new preferred stock of the merged company.

Consolidated Vultee, upon consummation of the merger and on the basis of present outstanding stock of the constituent firms, will have a capitalization of 216,729 shares of $1.25 convertible preferred stock and 1,385,933 shares of common stock. Consolidated was organized in 1923 at Greenwich, R. I. In 1924, the company moved to Buffalo, N. Y., where it remained for a decade, then took permanent quarters in California. Vultee had its beginning in California in 1932 and has continued there.

Sale to A. W. Porter and associates of New York City of controlling interest in Taylorcraft Aviation Corp. is being negotiated by Fairchild Aviation Corp. according to partially confirmed Wall Street reports. Fairchild Aviation owns 165,000 shares of the 195,000 shares of Taylorcraft stock. Richard H. Depew, executive vice-president and general manager of the latter company, has resigned to become production coordinator of Fairchild Engine & Airplane Co.

Douglas Aircraft Co. has changed the date of its annual meeting of shareholders to the third Wednesday in April, instead of the third Wednesday in March.

United Air Lines, in a dividend announcement that took Wall Street completely by surprise last month, declared a payment of 50c a share payable March 1. This is the first dividend the line has declared since Dec. 1936, when an initial payment of 20c a share was made. W. A. Patterson, president, said the payment reflected increased passenger, mail, and express traffic in 1942.

Stockholders' suit against Sperry Corp., certain of its officers and directors, and Field Glore & Co. for an accounting and recovery of profits realized through the sale in 1935 of 401,951 common and 115,232 Class A shares of Curtiss-Wright Corp. stock has been dismissed in federal court. The action was instituted by Jules Piccard, a stockholder, who charged the defendants conspired to defraud Sperry Corp. of benefits to be realized from the stock. Federal Judge Rifkind held that no acts of waste, negligence, or bad faith were committed in the transactions.

Bell Aircraft directors have approved a proposal whereby the company is negotiating a $60,000,000 Regulation "V" loan from a group of bankers headed by the New York Trust Co. At the same time, the Square D Co. has completed arrangements with the National Bank of Detroit and several participating banks for a similar loan of $10,000,000, according to F. W. Magin, president. Latter loan is to provide additional working capital required for production of government contracts.

Jacobs Aircraft Engine Co. also has arranged a $6,000,000 'V' loan with a group of Philadelphia banks headed by the Pennsylvania Co. for Insurance on Lives & Granting Annuities. The loan is to provide more working capital.

Defense Plant Co., subsidiary of the Reconstruction Finance Corp., has increased its contract with Chrysler Corp. to provide additional plant facilities in Illinois at a cost of $16,900,000. This increase results in an over-all commitment aggregating $173,000,000. It had previously been announced that Chrysler was building an aircraft engine plant in Illinois which is said to be the largest factory in the world.

Other recent Defense Plant commitments to increase plant facilities include Douglas Aircraft, $1,565,000; Liberty Aircraft Products, $180,000; Briggs Manufacturing Co., $700,000; Aviation Corp., $800,000.

By RAYMOND L. HOADLEY

Repeal or drastic modification of the war contract renegotiation law, which was enacted a year ago, now appears much less likely than it did a few months ago. Complaints against the law are still coming to members of Congress—but not in their former volume.

One reason may be the recent change in Army policy which now provides for the adjustment of prices each three- to six-month period over the life of a contract. This means that prices set at the beginning of each period are final and not subject to renegotiation. If a contractor is able to drive his costs down in the first period, and pave the way for reduced prices to the government in the next period, he is allowed a premium in the form of a somewhat larger margin of profit.

As an alternative to the fixing of final prices at the start of each period, provision is made for price adjustments at the period's end and the adjusted price is not subject to renegotiation. Thus, when a contract is completed, it is closed insofar as the recapture of profits is concerned. From the standpoint of stockholders, this new policy seems to be a great improvement over the former procedure. As things stood before, the final steps in renegotiating contracts might not take place for as long as three years—a long period during which neither management nor shareholders would know just where a company stood profitwise. And it might be added, the annual financial reports of the aircraft manufacturing companies now being issued give evidence that this group, which has become the No. 1 American war industry, is just as keen as the government is to stabilize earnings at moderate levels.

In the meantime, most of the major airlines have sustained some rather severe adjustments in mail rates at the hands of the Civil Aeronautics Board, and further adjustments are even now in the making with respect to incoming revenues. The CAB has served notice that it is about to effect a cut in passenger fares. Action of this sort has been in the wind for some time past, so the announcement, when it comes, should be no surprise to Wall Street or the market in air transport stocks.

Bendix Aviation Corp. is the first of the large aircraft companies to report on 1942 operations. The volume of war production has increased to 20 times that of prewar levels, according to Ernest R. Breech, president, with one-third of this increase in new types of devices that were not even on the market in 1938. While net sales for the fiscal year ended Sept. 30, 1942 reached a record total of $459,189,026, nearly three times the sales of $166,596,195 in 1941, net income amounted to $12,464,196 or $5.90 a share compared with $13,267,988 or $6.30 a share in 1941. The sum of $4,185,160 was added to postwar contingencies last year, bringing the total to $7,380,833. Net working capital at the fiscal year-end stood at $30,960,284, a gain of $13,353,014 for the year.

Some inkling is given by the Bendix report of the vast war contract price reductions and profit renegotiations now going on in the aircraft industry. Price reductions made last year aggregated $123,000,000. Yet the company has further agreed to refund to the government an additional $65,400,000 as a result of contract renegotiation. The greater portion of this amount would otherwise have been payable as additional income and excess profits taxes.

Air Investors, Inc. has withdrawn the exchange offer made Dec. 28, 1942 to holders of its convertible preferred stock, and any shares deposited after Jan. 18 will be returned. The company's net assets last year rose to $1,023,349 or $2.35 a share as against $344,905 or $1.25 a share at the 1941 year-end.

National Aviation Corp., largest of the aviation investment trusts has announced an important policy change through its president Frank F. Russell. Whereby investments will be made in other than aviation stocks as conditions change and when such investments serve the company's interest. However National will continue to specialize in the aviation field. Net assets as of Dec. 31, 1942 totaled $6,808,730 or $14.80 a share compared with $6,865,227 or $14.38 a share in 1941.

Changes made by investment trusts in their aviation holdings last year included the sale by National Aviation in the final six months of 1942 of 800 shares of Consolidated Aircraft, 9,900 Glenn L. Martin Co., 1,000 Republic Aviation; 2,000 Vultee Aircraft;

3,400 American Airlines, 3,600 Pan American Airways; and 4,200 United Air Lines. Purchases included 3,100 Bell Aircraft, 2,500 United Aircraft; and 1,700 Chicago & Southern Airlines. At the same time Incorporated Investors bought 14,200 shares of Northwest Airlines in the final quarter and increased its holdings of United Air Lines to 20,000 shares from 20,000 shares.

Continuing with the Bendix report: Mr Breech felt unable to give stockholders any assurance as to future dividend policy. He called attention to the quarterly dividend reduction effected last year in order to provide protection against the risks involved in the tremendous wartime expansion, but he added his conviction that shareholders are entitled to a substantial return on their investment.

Control of Adel Precision Products Corp, Burbank, Calif., has been obtained by the Transamerica Corp through acquisition of more than 445,000 shares of Adel stock according to the latter's president, H Ray Ellinwood. Terms of the purchase provided for the exchange of 15_{100} shares of Bank of America N T & S.A. common shares for each nine shares of Adel stock. Five year management contracts were signed with Ellinwood and Robert D Cavenaugh, Adel vice-president, while the new board of directors include two Transamerica officials, W L Andrews and Charles Schimpff, also William De Ridder, president of General Metals Corp. No change is contemplated in the Adel management.

United Air Lines has had its mail rate cut $1,700,000 by the Civil Aeronautics Board. The new rate of .3 mill per lb-mi is the same as had been previously applied to Eastern Air Lines, American Airlines, and Pennsylvania-Central Airlines. The board estimates that United will have a profit of $8,345,222 this year, figured before income taxes.

On the Raw Materials Front

THE SHIPPING SQUEEZE threatens to cause a temporary shortage in the supply of aluminum metal, so vital to aircraft production. There haven't been enough ships assigned recently, war production officials point out, to bring in the necessary quota of high grade bauxite from South America. This has resulted in a shortage of calcinated alumina, causing in turn a comparable shortage of aluminum.

But fortunately the time is soon coming when the United States will be independent of foreign importations of bauxite ore which comes in from Surinam, formerly known as Dutch Guiana. Nearly two years ago the War Production Board laid plans to speed the output of bauxite in the Arkansas field. As a result, domestic production jumped from 373,307 tons in 1939 to around 900,000 tons in 1941, and it has been in an upward curve ever since. At the same time, mine development has been intensified to the point where Philip D. Wilson, aluminum production chief in WPB, feels that new drillings will nearly, if not quite, maintain reserves.

At the same time, new plants have been constructed to use the low grade domestic bauxite, and older alumina plants are being converted to domestic ore. In peacetime, the aluminum industry had leaned heavily on the foreign high grade ore because of economic considerations. Thus the government is financing the conversion of these older plants. Result will be that the United States should be completely independent of Surinam imports by early summer. Furthermore, by September the needs of Canada should be supplied as well. This will assure not only a continuous supply of aluminum metal, free from shipping hazards, but also save cargo space and the naval forces now required to assure safe transportation of this vital ore.

Meanwhile, the WPB estimates that nine new aluminum ingot plants already in production or rapidly nearing completion will give the United States a total supply of about 3,000,000,000 lb. per yr. before the end of 1943. Just before Pearl Harbor, the rate was 917,200,000 lb. per annum; by last January it had soared to about 2,300,000,000 lb a yr.

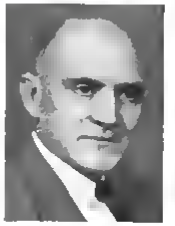
Before the shipping situation became so threatening, the aluminum supply problem had centered almost exclusively around fabricated parts rather than aluminum metal. There has been a tremendous expansion in aluminum fabricating facilities, of course, but because of the longer time required to construct forging, rolling and extruding mills, they will not catch up with ingot production until sometime later this year.

As in the case of other war industries, labor shortages have become critical in the aluminum field in recent months. War production officials admit that this limitation on production will continue to be a grave problem.

Aviation People

J. P. DAVEY, former works manager of the Ohio and Missouri plants of Curtiss-Wright's Airplane Division, is named general manager of the Ohio plant to be responsible for Helldiver and Seagull engineering and production

A. LEWIS MacCLAIN, Pratt & Whitney aircraft engine test pilot and engineer, was awarded the Octave Chanute Award by the Institute of The Aeronautical Sciences for outstanding work in flight testing of engines and development of engine torque indicater, and F. W. REICHELDERFER, chief of the U. S. Weather Bureau and former meterological officer in the U. S. Navy, was awarded the Robert M. Losey Award in recognition of outstanding contribntions to the science of meterology as applied to aeronautics



BARTON T. (RED) HULSE, test pilot and chief of Curtiss-Wright's Ohio Airplane Division flight test section, has been promoted to the organization's new Research Division where he will flight test new plane models for the firm.

J. D. SHERMAN, in the machine tool field for over 40 yr, is named plant manager of the N. J. factories of Curtiss-Wright's Propeller Div. He comes from Willys-Overland where he inaugurated mass production methods.

A. F. ARCIER, chief engineer at Waco since 1930, has been elected to a newly created office that of vice-president in charge of engineering, and is also one of the two new directors of the company added to the expanded board.

Herris & Ewing Photo

JESSE W. LANKFORD has been appointed director of the CAB Safety Bureau, succeeding Jerome C. Lederer. He is former chief of CAB's Accident Analysis section before that was with the Dept. of Commerce aeronautical branch.

Richa. T. B. Holl Photo

W. A. HAYWARD has been appointed vice-president and manager of Intercontinent Aircraft Corp. He was AAF Representative at the Vultee Field Division for a year and a half before his retirement from service last year as a Colonel

Tommy Weber Photo

Lejt Gorsha Photo

KEN ELLINGTON has been appointed director of information for the Aircraft War Production Council East Coast Inc., and JOHN H. RODICK has been named assistant general manager. Mr. Ellington was formerly public relations and radio executive for the Aeronautical Chamber of Commerce before that was news editor and commentator for a radio station. Mr. Rodick was formerly with the State of Maine Publicity Bureau and before that served with the New York World's Fair promotional department.

P. H. CUMMINGS has been appointed Air Traffic Executive and J. M. SHANAPHY executive representative of Railway Express. Mr. Cummings will direct and further develop Air Express transportation, particularly the coordination of air and rail express. Mr. Shanaphy, whom Mr. Cummings succeeds, was formerly with the transportation department of the agency as special representative of the traffic vice-president until he was appointed superintendent of transportation, from which post he moves on to Air Traffic Executive

Universal Press Photo

IRVING H. TAYLOR, manager of the Aeronautical Chamber of Commerce of America, Inc., pending reorganization. He is secretary of the Chamber and head of the Post-War Development Department.

RICHARD H. DEPEW, JR., is named production coordinator at Fairchild Aircraft. Many of his industry years have been associated with the firm's interests since 1926 when he test-flew the first Fairchild-built plane

ALEXANDER KARTVELI, Republic Aviation v. p. and chief engineer, has received the honorary degree of Doctor of Science from Temple University in Philadelphia. The honor was conferred for his design of the P-47 "Thunderbolt."

Recent Books

The First Air Voyage in America. *Published by Penn Mutual Life Insurance Co., Philadelphia. 89 pages.*

An account of the 45th balloon flight of Jean Pierre Blanchard, who first ascended in this country from the old Walnut St. prison yard in Philadelphia on Jan. 1793, in the presence of President Washington and other notables and came down 46 min. later in Woodbury, N. J., 15 miles away. Also contains copious notes (by Carroll Frey) on the geography and chief citizens of the city and descriptions of the flight from contemporary papers, together with a "fac simile reprinting" of the famous aeronaut's own journal.

How a Plane Flies, *by Charles Gilbert Hall. Published by Funk & Wagnalls Co., New York. 235 pages, illustrations, bibliography, index, $2.*

A deceptively simple, sometimes too condensed junior high school explanation of the principles of engines, equipment, planes, and the tasks of men who keep them flying, presented with a good portion of romance. Salient part of book is portion following the text which contains a list of sources of trade information and an extensive bibliography.

Plastics Catalog 1943, *edited by Dr. Gordon M. Kline and others. Published by Plastics Catalogue Corp., New York. 864 pages, illustrations, bibliography, trade directory.*

Current developments and processes in the plastics industry encyclopedically analyzed in a series of short, authoritative articles arranged in sections on finishings, coatings, and materials and their general characteristics, available forms, methods of fabrication and applications.

Use of plastics in war has inspired a new chapter covering government departments working in this field, a special article on engineering design, and descriptions of new developments in plywood. There are also sections on synthetic fibers and synthetic rubbers and rubber-like substances, with large charts on properties, formulas, solvents, and plasticizers.

Weather, An Introductory Meteorology, *by W. G. Kendrew. Published by Oxford University Press, New York. 96 pages, index, $1.*

Climate and its variations, atmosphere, winds, clouds, visibility, and the principles of forecasting are here explained to student pilots in elementary form.

Aero-Engines, *by D. Hay Surgeoner. Published by Longmans, Green and Co., New York. 110 pages, index, $1.25.*

Rudiments of internal combustion engines and their adaptions to aircraft explained in simple text and drawings for students not familiar with the fundamentals.

Radio Navigation for Pilots, *by Colin H. McIntosh. Published by McGraw-Hill Book Co., New York. 171 pages, illustrations, diagrams, index, $2.*

Radio navigation, Mr. McIntosh feels, requires "the ability to visualize the problem at hand into a mental diagram . . ." Granted, books will not give one's position over Skunk Hollow, but this one comes as close as any could in telling the commercial pilot, for whom it is chiefly intended, how to interpret the message stuttering in his earphones.

Mr. McIntosh has set himself the task of selecting and presenting "only the basic information and essential techniques that a pilot needs" to reach a desired destination. He covers this assignment in succinct chapters on radio navigation and range systems, then proceeds to explain the principles and employment of direction finding loops, radio compasses, and obtaining fixes.

Problems in Blueprint Reading, *by Drew W. Castle and edited by R. W. Selvidge. Published by Manual Arts Press, Peoria, Ill. 93 pages, 9x6.*

This introduction on how to read blueprints does not require any preliminary instruction in mechanical drawing, but does employ freehand sketches (and questions) to increase the student's absorption of the chief points in the 33 problems which follow the explanatory text.

A Bibliography of Aviation Medicine, *by Ebbe Curtis Hoff and John Farquhar Fulton. Published by Charles C. Thomas, Springfield, Ill. 237 pages, indices, $4.*

Six thousand citations on every conceivable effect of flight on the body, compiled according to subjects and authors from 800 American and foreign journals. This work was prepared for the Committee on Aviation Medicine of the National Research Council, which prior to sale of book requires the name of every purchaser for its records.

Flying Health, *by M. Martyn Kefka, M.D. Published by Military Service Publishing Co., Harrisburg, Pa. 248 pages, illustrations, $2.*

It takes two machines to keep a plane in flight—one in the power nacelle, the other in the pilot seat. To give the human machine "the advice and knowledge" required to keep in flying condition, Dr. Kufka describes at some length various major vital organs of the body and the defects to which they are heirs under varying flying conditions and climates.

He gives some very stern advice and strict admonitions re temperance. Outstanding, however, is the excellent grasp he offers of the more primary, all-controlling physical forces which can ground a man permanently.

High Adventure, *by A. H. Cobby. Published by Robertson & Mullens, Melbourne, Australia. 203 pages, appendix, illustrations, 6/6.*

Experiences of an Australian aviator over the front lines in World War I.

Aeronautics Workbook, *by Cornelius H. Siemens. Published by Ginn and Co., New York. 174 pages, paper bound, $1.*

Seventy-five problem sheets covering aerodynamics, meteorology, navigation and power plants for use in connection with standard preflight and ground school introductory texts.

A.S.T.M. Standards on Petroleum Products and Lubricants, *Published by the American Society for Testing Materials, Philadelphia, Pa., 442 pages, paper bound, $2.25.*

Latest edition of this annual contains definitions and specifications of various oils and by-products, plus descriptions of some 87 standard test methods for analyzing petroleum and its derivatives. Also included is proposed test on potential gum in aviation gasoline.

Visibility Unlimited, *by Ernest G. Vetter. Published by William Morrow and Co., New York. 352 pages, illustrated, index, $3.50.*

Fundamental, beautifully illustrated introduction to the study of weather and aviation to familiarize preflight students with the requirements of the CAA examinations and supply a basic understanding of the advanced courses taught by the services.

In brief, dett chapters the author, a veteran private pilot and naval instruction duty, explains winds, temperatures, air masses. Then he outlines the principles of aviation and modern aviation instruments including radio. Finally he takes his reader for a flight to show him how to use his previous instruction.

Bombs Away, *by John Steinbeck. Published by the Viking Press, New York. 185 pages, illustrated, $2.50.*

For information of laymen and to spur youthful enthusiasm, this forceful novelist toured training centers and

flying fields for the Army Air Corps and brought back a fictionalized report of how bombardiers, gunners, navigators, pilots, and radio operators are trained. How they learn to function aloft as a team is emphasized.

Lubrication, *by the late Arthur Edwin Norton edited by J. R. Muenger. Published by McGraw-Hill Book Co. New York. 244 pages, references, index. $3.*

Mathematically exhaustive introductory text for practicing engineers. Covers friction, viscosity, properties of lubricants, and hydrodynamic theory of bearings.

Aircraft Detail Drafting, *by Norman Meadowcroft. Published by McGraw-Hill Book Co. New York. 211 pages, illustrated, appendix, index. $2.25.*

A lucid, introductory text on materials and standard methods of designing and manufacturing parts and fastenings. Intended for young engineers expecting to specialize in "specific phases of aircraft drafting," this book is an amplification of a course in drafting standards given last year at the University of California, Los Angeles, for aircraft workers. It includes 46 examination questions.

Principles of Aeronautical Radio Engineering, *by P. C. Sandretto. Published by McGraw-Hill Book Co. New York. 414 pages, appendix, index. $3.50.*

Mathematical description of the principles and operation of commercial aircraft radio equipment, chiefly direction finders, communication, instrument landing, and power supply systems, and absolute altimeters. Information, which author believes to be the first covering this field, was drawn mainly from private and government laboratory reports.

Motion Study for the Supervisor, *by Norman R. Bailey. Published by McGraw-Hill Book Co., New York. 111 pages, index. $1.25.*

Simple explanation of the ways and whys of motion study intended to stimulate the interest and cooperation of shopmen on the theory that "there is no team sense to pay dividends than a motion-minded supervisor cooperating with a competent motion-study analyst."

Die Casting for Engineers. *Published by the New Jersey Zinc Co. New York. 148 pages, illustrated, index. $1.*

Brief non-technical outline of the history and present processes of designing and preparing dies and of finishing various alloy castings.

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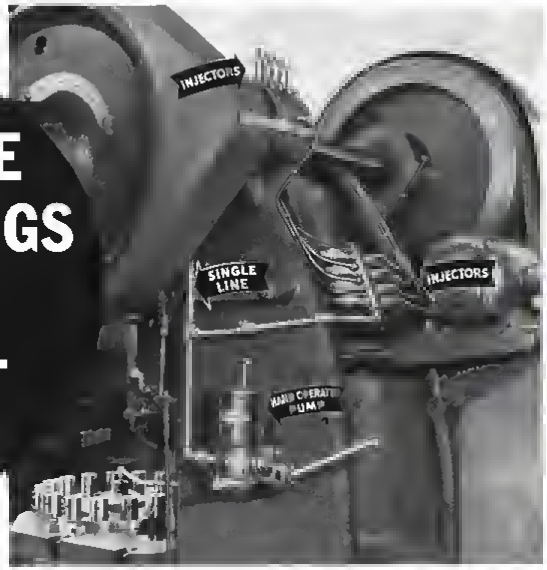

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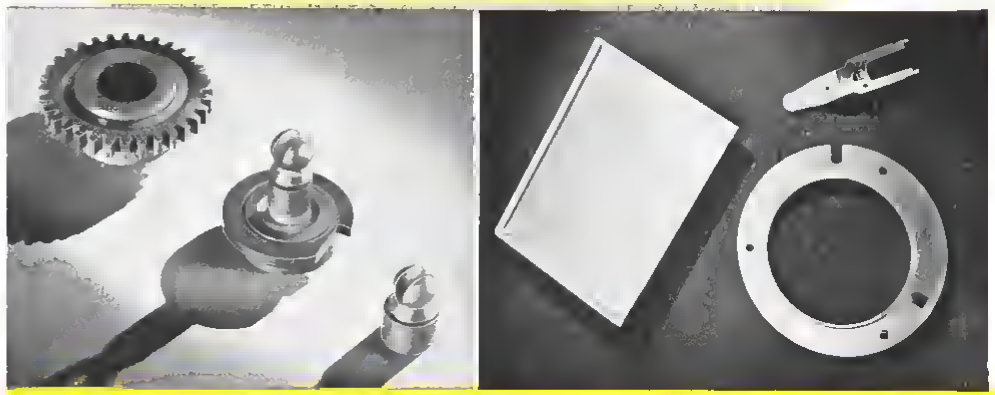

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Burring, Buffing and Polishing . . . Specialists in the Development of Production Methods and Compositions

Glue in Aircraft Construction

(*Continued from page* 133)

wood passing AN-NN-P511b belong to these three classes. Phenol-formaldehyde resin, melamine formaldehyde resin, and urea-formaldehyde resin fortified with boil-proofing agents. The AN-NN-P511b specification is directed solely at obtaining suitable aircraft plywood possessing the highest permanent strength properties. The three classes of adhesives described will, when used properly, make the highest quality bonds.

Nature of Plywood

Manufacture of aircraft plywood is a process which involves the making, from a relatively non-homogeneous material such as a birch log, of a new product in the form of thin aircraft plywood with different and more uniform strength properties. These strength properties vary, depending on the following factors:

1. Wood species and density[4]
2. Thickness of plies and construction[5]
3. Moisture content[6]
4. Quality of adhesive bond.

On the fourth factor—quality of adhesive bond—depends the strength values which the aeronautical engineer must use in design work. Specification AN-NN-P511b sets the lower limit in pounds per square inch for the standard plywood shear test. The shear value obtained for any given specimen is influenced by the character of the adhesive bond. Visual examination may show that a specimen failed entirely within the wood while the glue line remained intact. The shear value obtained in this case represents the shear value of the wood and not of the glue. On the other hand, visual examination may show that a specimen failed entirely along the glue line. The shear value obtained in this case is the shear value of the glue and not of the wood.

Naturally, for use in aircraft the highest shear values are desirable and usually are accompanied by a high percentage of failure in the wood. It must be remembered, however, that this standard plywood shear test involves other stresses than pure shear. The maximum value obtainable in the plywood shear test with 100 percent wood failure is approximately only ¼ to ⅓ of the shear value parallel to the grain, as given for similar timber specimens in Table 21 of Technical Bulletin No. 479, Sept. 1935, U. S. Department of Agriculture.

Importance of Proper Stock

In order to manufacture aircraft plywood it is necessary to have adequate supervision of the processed material from the moment the tree is felled. Logs, for example, may deteriorate on standing. It is frequently necessary to coat the ends of the blocks with preservative paint in order to diminish checking and prevent destruction of the wood by molds and the like. When handling ⅛-in. veneers in summer, it is necessary to maintain comparatively high moisture content in the veneer prior to the actual plywood gluing process in order to avoid unnecessary loss in breakage and splits. Ordinarily 6 to 10 percent moisture content is found adequate in preventing these breakage losses.

The moisture content of the stock before gluing up is of great importance, since steam from high moisture content veneer may cause blisters in the finished panel during the hot pressing operation. Apparently the resin adhesive is made extremely fluid by the steam and is dissipated into the wood, while at the same time steam pressure due to the volatilization of moisture from the wood and from the adhesive builds up to greater than atmosphere pressure so that on opening the press a small steam explosion occurs, disrupting the bond. The aircraft plywood manufacturer usually corrects this condition either by some drying of his veneer or lowering of the pressing temperature and extending of the pressing time.

Panels containing blisters should never reach the aircraft plant, but a variation of this trouble may be found in some panels glued with alkaline phenolic adhesives. In such panels the alkaline adhesive has over-penetrated—because of too high moisture content—and actually coated the external face plies. This may be particularly evident in very thin mahogany plywood where the large pores make over-penetration easy. Such a glazed surface is difficult to bond in secondary gluing, since the pores of the wood are effectively sealed with a highly water-resistant sealer.

Protection-Coated Veneers

For the same reason, waxed end boards should not be used in contact with aircraft veneers or plywood, since the pores of the wood may be filled and the wetting character of the surface altered.

Frequently the question arises as to whether it is possible to bond aircraft plywood which has been sealed with a surface protecting coating to minimize dimensional changes. It is not possible to make the highest quality joint in secondary gluing, using cold process resin or casein glue, if the surfaces to be joined have been sealed with a surface protecting coating or preservative treatment prior to gluing, since the

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sealer prevents the glue from penetrating the wood fibers.

The best procedure is to seal those surfaces requiring a protective coating or preservative treatment *after* all gluing has been performed. And best results are obtained in secondary gluing by using aircraft plywood in which the surface approximates as closely as possible the roughness and lack of sizing found in the original veneer.

Glues for Bag Molding

One of the major developments of the last few years has been the bonding of thin veneers into various curved parts by the use of rubber bags in various bag molding processes (see AVIATION, Oct. 1942). In all of these processes the thin veneers are coated with thermo-setting resin and allowed to air dry. These coated veneers are assembled on a form, then fluid pressure is applied through a rubber bag to bring the veneers into contact and simultaneously to form them into the curved shape desired. Heat is applied either through the rubber bag or through the mandrel about which the veneers are molded. Glues satisfactory for this purpose are those from which plywood of AN-NN-P511b grade can be made, namely: Phenol-formaldehyde resin, melamine-formaldehyde resin and urea-formaldehyde resin fortified with boil-proofing compounds.

It is important that the veneers be perfectly coated with resin adhesive. This is best accomplished by a mechanical glue spreader equipped with smooth or symmetrically grooved rubber rolls. A spread of 9 to 12 lb. of dry resin solids per 1,000 sq.ft. of surface to be glued is usually satisfactory. The resin adhesive is allowed to dry after spreading in order to facilitate handling. Handling of wet spread veneer is apt to give rise to wiped areas with no glue and overlap on assembly. The amount of pressure necessary to form the veneers around the mold depends upon the curvature of the mold, the thickness of the veneers, and the adhesive, and this pressure varies from 14 to 200 psi.

Pressure should be applied before, or simultaneously with, the application of heat. Since wood is plastic under the influence of heat, time and temperature affect the amount of pressure required for proper bonding. Lower pressures will be more effective at higher than at lower temperatures, and lower pressures are more effective the longer their duration. This is important where pressures are obtained by means of the vacuum bag. In all cases it is important that the finished glue line be continuous and not thicker than approximately .005 in.

After the aircraft plywood and va-

rions molded shapes are fabricated they must be bonded onto the structural members of the plane. This job of secondary glueing is done with cold setting urea resin or water resistant casein glue. Government specification AN-G8 covers the cold setting urea resin and Federal Specification CG456 covers the water resistant casein glue which is used for this purpose. Casein glue has the advantage of not being as sensitive to temperature differences as cold setting urea resin, and some manufacturers prefer to use it because they find it fills the requirements of their glueing process better than cold setting resin.

Requirements for Good Bonds

It is well known that cold setting urea resin glues are completely resistant to attack by molds and fungi. A casein glue bond, however, may gradually lose its strength if subjected to high relative humidity (97 percent or better) under conditions favorable to mold growth for several years. (Preservatives or mold inhibitors are incorporated in most aircraft grade casein glues.) A good bond made with cold set urea resin glue because of its superior mold resistance may be superior to a good bond made with casein glue, but a good casein glue bond capable of lasting several years may still be better than a poor bond made with cold setting urea resin which might be capable of lasting through only one flight. Poor bonds have been made with cold setting urea resin glue for a variety of reasons, but chiefly because of—

1. Lack of continuity of glue film (inadequate glue spread).
2. Thick deposit of glue due to insufficient pressure or too long assembly time.

Specification AN-G8 has as its object the selection of cold setting urea resin adhesive to eliminate bond failures. The use of certified batches of resin glue which have been tested and approved will eliminate the possibility of failure. Further than this, temperature and working conditions must be satisfactory for the glue being used. The glue manufacturers' recommendations will be helpful in this respect (see U. S. Air Corps, Wright Field, memorandum report MDAC-266-WF-11-15-41-60M).

Some bond failure is due to what we prefer to call lack of continuity of glue film. By this we mean to include all of the various types of "starved bond" which, roughly, may be classified as caused by—

1. Inadequate glue spread.
2. Over-dilution of glue with water.
3. High moisture content of wood stock being glued.

4 Excessive pressure for the viscosity of the glue.

Correction for each of the above troubles is obvious. It is possible to make a poor bond with cold setting urea resin glue if clamping pressure is removed before the glue has set up. The members being glued spring apart, causing a discontinuity. Clamping pressure should be retained for 2 to 3 hr. after the resin glue used has set up. Temperature has a very marked effect on the working life of cold set urea resin glues. A rise in room temperature of 15 deg. F. will diminish the working life of the glue by 50 per cent. A fall in room temperature of 15 deg. F will increase the working life by 100 percent. And too low a room temperature will prevent the resin from setting to the degree necessary for maximum strength and water resistance.

For best results, the glueing room should be maintained at an even temperature held within plus or minus 2 deg. F. Clamping pressure should always be maintained for 2 to 3 hr. after the bead of glue squeezed out at the joint has hardened. In a hot dry atmosphere, it is possible to observe another type of glue bond failure—that caused by discontinuity. The glue sets up before pressure is applied. This trouble may be corrected by working at a lower temperature or by the use of a slower catalyzed resin mixture.

Probably more poor bonds have been made by using cold setting urea resin glue as a crack filler than through any other single cause. We do not mean that urea resin glues have been deliberately used to fill cracks but rather that under the conditions of use the glue line has been allowed to be too thick.

Affects of Aging

It is evident that with increasing film thickness of resin adhesives between two blocks of wood, the modulus of rupture falls off very rapidly from the modulus of rupture of the wood as the glue film thickness is increased, and the failure seems to occur at the juncture of the glue and the wood. Cold setting resin adhesives undergo chemical change on aging. These changes are more pronounced in large masses of resin, such as the squeeze-out of excess glue from a glue line under pressure. These beads of resin are very hard for some time after glueing, but all of them will eventually crack due to internal stresses set up, possibly by the release of formaldehyde and water due to chemical reaction on aging.

In a thin film these materials are effectively removed as rapidly as they

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are formed, and the resin film adjusts itself without the development of deleterious fracture planes in the film. This is not so in the large mass of resin adhesive, due to the inability of the formaldehyde and water to escape from the interior. For practical purposes the limiting thickness of a glue film between wood surfaces is probably .005 in.

Each Part a Separate Glue Problem

Each portion of the plane assembly being fabricated from aircraft plywood and structural spruce timbers must be considered a separate glueing problem, since the amount of pressure necessary to make adequate contact between the surfaces being bonded varies with the thickness of the material used and the imperfections in the surface. The moisture content of the stock for cold process glueing must be between 8 and 12 percent to make sure that the finished assembly will not be subjected to abnormal strain arising from the taking on or losing of moisture from the atmosphere.

The ideal glue joint is one in which redistribution of moisture added by the adhesive causes the smallest amount of strain due to the expansion and contraction of wood coming to equilibrium in the atmosphere.

All resin adhesives set due to chemical reaction and the abstraction by the more hydroscopic wood of the water or solvent in which they are dissolved. Cold set urea resins have been catalyzed to set at room temperature. This setting, which is accomplished in 5 hr. at 70 deg. F., is greatly accelerated by increased temperature so that setting may occur at 90 deg. F. in about 2 hr. Further if the cold setting urea resin is used under hot pressing conditions, setting may be accomplished in a matter of a couple of minutes at 220 deg. F.

Pressing time and temperature are so related that a long pressing time at a low temperature is equivalent to a shorter pressing time at a higher temperature. Cold setting urea resin and hot setting urea resin may be considered the ends of a continuous series of adhesives having varying setting properties. For its most effective use the adhesive should be tailored to fit the operating conditions of the process at hand. Since heat is most effective in speeding up the setting of urea resin adhesives, it may be applied by a number of different methods. First, possibly steam or electrically heated platens; second, clamped assemblies in kilns or ovens, third, radiant heat from either resistance heaters or infra-red lamps; and fourth, high frequency electrical fields.

For each method of applying heat,

there is a most effective method for handling the gluing process. Here again, a tailored glue has more advantage than the run of the mill adhesives, since the greatest production is attained when the time under pressure is at a minimum.

REFERENCES

[3] See Technical Bulletin 479 *Strength and Related Properties of Woods Grown in the United States*, U. S. Department of Agriculture page 17 Sept. 1935 *ANC Handbook on The Design of Wood Aircraft Structures*, July 1942, page 12 (a restricted publication.)

[5] See Technical Bulletin 479 *Strength and Related Properties of Woods Grown in the United States*, U. S. Department of Agriculture page 48 Sept. 1935 *ANC Handbook on The Design of Wood Aircraft Structures*, July 1942 pages 8 and 220 (a restricted publication)

[6] See Forest Products Laboratory Bulletin No. 1302 *Data on the Design of Plywood for Aircraft*, page 2 Dec. 1941 *ANC Handbook on The Design of Wood Aircraft Structures*, July 1942, page 7 (a restricted publication)

[4] See Forest Products Laboratory Bulletin No. 1302 *Data on the Design of Plywood for Aircraft* pages 7-9 Dec. 1941 *ANC Handbook on The Design of Wood Aircraft Structures*, July 1942, page 26 (a restricted publication) *The Technique of Plywood* by Charles B. Norris.

[5] See Forest Products Laboratory Bulletin No. 1302 *Data on the Design of Plywood for Aircraft* pages 6-7 Dec. 1941 *ANC Handbook on The Design of Wood Aircraft Structures*, July 1942 page 26 (a restricted publication) *The Technique of Plywood* by Charles B. Norris.

[8] See Technical Bulletin 479 *Strength and Related Properties of Woods Grown in the United States* U. S. Department of Agriculture page 48 Sept. 1935 *ANC Handbook on The Design of Wood Aircraft Structures*, July 1942 pages 8 and 220 (a restricted publication) *The Technique of Plywood* by Charles B. Norris.

Substitute Materials

(*Continued from page 115*)

Much valuable material on aircraft woods and manufacturing has been made available by the U. S. D. A. Forest Products Laboratory, the Navy Bureau of Aeronautics, and Army Air Forces Materiel Center. This has been drawn upon and coordinated to comprise, in the *Manual*, a set of Vultee standards and requirements to supplement information supplied by engineering drawings.

As detailed therein, selected wood must be stored and handled under controlled atmospheric conditions. For best strength-weight ratio and advantageous gluing, lumber and plywood must have a moisture content of 5 percent when applied with water-solution glue. Application of the latter will cause a "pick-up" of moisture to approximately 9 percent. When dry adhesives, such as Tego film, are used, veneers must be in the same condition required for lumber. This also applies when the new urea glues, that are sprayed on and allowed to dry before pressing, are employed.

The new synthetic resin glues, such as urea formaldehyde, are water-and-fungi resistant. This, plus their greater penetrative and adhesive qualities, has

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made practical much that could not formerly be done in manufacturing airplane parts of wood.

These glues, however, require special handling and conditions. For safety, their working life should be held to 2½ hr. under atmospheric conditions where the temperature is 72 deg. F. and the glue's moisture content is not less than 45 percent. The glue must not be adulterated by residue from previous batches left in receptacles.

As to assembly procedures, a minimum of 5 min. open-joint time, and not over 15 min., is requisite. Adhering surfaces vary with practically every difference in origin, kind, and fabrication method of the wood used. In any case the surface to be glued must not be too smooth. Contours of joining parts must match precisely. Methods of clamping them must be such that even pressure of at least 50 p.s.i. will be maintained for a minimum of 8 hr. if the temperature is 72 deg. F.

The moisture content of wooden parts must be "sealed in" by application of suitable finishes. A defective finish on metal from sealing of the paint, becomes apparent in time to permit refinishing before serious corrosion results. Defective wood finishes usually are manifested by checking or splitting of the material itself and can be remedied only by replacement.

Furthermore, airplane finishes must be capable of withstanding the rigors of field use. In addition to extreme atmospheric conditions, planes are sometimes steam cleaned on the service line and, during takeoffs and landings, are scoured and scratched unmercifully by flying sand and gravel.

Wood Meets Stress Requirements

Rigid adherence to the manufacturing techniques established enables Vultee's subcontractors to produce parts that embody the design specifications developed by engineers. In all wood designs, it has been possible to realize exceptionally high strength without increase of weight, as compared to metal.

The pilot's seat, built of birch plywood, withstood 160 percent of design load, having supported 1½ tons. An aileron, 2½ lb. lighter than the original one of metal, carried 380 percent of design load. The rudder stood up at 240 percent and is ½ lb. lighter.

The wood fuselage monocoque proved its toughness under the most severe test loads. At 180 percent design load, deflections and distortions were negligible. Failure finally occurred at 177 percent, after which it still supported 12 percent more load than is actually applied in flight.

The horizontal and vertical stabilizers are slightly heavier than the metal ones, but the rudder and elevator are under-

weight by an amount that makes the entire wood empennage lighter than the former metal one.

At first thought, it might appear that such margins are too great and the design inefficient. But there are other factors dictating high strength requirements. Certain minimum sizes of materials must be adhered to in order to maintain rigidity and withstand hard service use. Practical and economical design for production is a consideration. Excess margins must be allowed to compensate for variations in manufacture and glueing, no matter how carefully controlled.

It is true some margins are much higher than this would require, but they could not be cut down without risking a finished form that might develop sags and wrinkles.

A very good example of this is the vertical stabilizer. This surface was originally designed with ⅛-in. skin covering. In test, a tension failure developed at 240 percent of design. The ⅛-in. skin surface, however, was too wavy for an acceptable article and was changed to 3/32-in. thickness, which is considered the minimum necessary in a surface of this size.

Center section flap skins were beveled up on the bottom side, even though the part already was over-strength. In test, the ⅛-in. skin failed at 380 percent of design limit, but it seemed somewhat flimsy to resist impact from flying rocks caused by the slipstream or water from wet field landings. Here, again, the skin thickness was increased to ⅛-in. this time to withstand hard service use.

The wooden monocoque is 1½ lb. heavier than the former one of metal. It is covered with birch plywood. Birch has the toughness to resist impact from flying rocks, and the ⅛-in. skin is desirable because anything thinner might be ruptured in rough ground crew handling.

Other Materials

As to plastics, a fabric-base phenolic known as Panelyte thus far has proved most successful among those available. It is used for practically all fairings, inspection doors, and for side panels. Of about the same weight as metals formerly used for this purpose, it lends itself to forming in three dimensions, and can be riveted. In constructing side panels, the material is joined to a supporting channel stringer.

Experimentally, the phenolic sheets have been applied as skin over stabilizer surfaces. Under severe vibration of 50 hr. with full design loads, they withstood every test in an excellent manner. Deformations were small when they were put under severe tests to determine creep of the structure. No noticeable

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effect was observed after 6 hr. and, upon release of the load, the structures returned to normal in a short time. Results of the tests indicate new uses for the material in future production applications.

While this reaches further ahead than production, thus far, has been carried in the use of new materials, it dovetails with the second phase of Vultee's conversion program—that of employing low alloy steels and magnesiums.

In fact, events have so shaped themselves that some developments of this second phase already have been called into use. Extrusions are becoming critical. So, likewise, are forgings. The latter are being replaced with castings and assemblies built up of welded steel. Cold rolling and drawing of sheet stock to supplant the need for extruded shapes is being undertaken.

Some of the applications involved relate to the experimental work by which Vultee is in position to make immediate recommendation for production of its trainers from low-carbon low-alloy steels when such materials shall have become available in quantity.

Meanwhile, intensive investigation is underway to develop production of planes from magnesium. One approach to the problem is being made with a view to covering existing structures with magnesium sheet. It is feasible in many instances to use magnesium of a gage slightly heavier than the original aluminum alloy skin. The added thickness gives greater rigidity and the progress of deterioration from corrosion is reduced, in terms of its percentage in relation to the gage of the metal.

Actual protection against corrosion is under intensive development, but little information can be made available at present.

By pursuing its long-range program of research, experiment, design, and testing, Vultee continues to anticipate and meet war production exigencies. Some of the more immediate applications, sketched in the foregoing, have released much essential material for output of combat planes, at the same time enabling Vultee to continue in fast, quantity production as the major supplier of basic trainers for the air services of all United States armed forces and those of several United Nations as well.

Plywood Fabrication

(*Continued from page 120*)

ting time could be materially reduced by the application of the high frequency method of heating. This would increase the capacity of expensive fixtures manifold.

Moisture content of the assembly is an important problem in all hot plate glu-

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Maker of Air History—

The North American B-25

Part of the wiring assembly of North American's B-25 Mitchell Bomber.

Wiring the pilot's switch box. Altogether, miles of wire are used on the B-25

ANOTHER PLACE

WHERE BELDEN WIRE GOES TO WAR

These swift, deadly B-25 Mitchell Bombers, built by North American, are active above all the world's major battle fronts. The fourteen-ton giants have unloaded bombs on the enemy from Tokyo to Tobruk —from Russia to New Guinea.

Here is another example of the way American ingenuity is winning the war. Here skilled workers, using service tested materials, have produced a weapon that stays "on the job." Here is another place where Belden wire goes to war!

Back of Belden aircraft wire is a lifetime of experimenting and testing—collaboration with aircraft engineers since flying was in its infancy. This vast experience makes possible the Belden wire that meets today's needs

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ing. With equipment such as Thermex, *heating is uniform throughout a piece of wood, causing no redistribution of moisture in injure the wood.* Too much moisture may cause steam to form near the surface or close to the hot plate. Hence, ordinary hot plate practice has been to use almost dry wood, of 2 or 3 percent moisture content, to prevent damage due to steam blisters. Then, after gluing, the recommended aircraft practice is to raise the moisture content back to 8 or 12 percent, or about its normal outdoor operating moisture content. Moisture content can be high, when high frequency heating is used, without likelihood of damage to the piece. This makes it unnecessary to dry airplane wood to such a low moisture content before gluing.

Rapid, uniform heating reduces the labor, glue costs, inventory, and floor space in any plant. It gives full and complete control of heat throughout the work at all times. The heat can be introduced or stopped instantly without releasing the press and removing the work, as when hot plates are used. When the electricity is cut off there are no hot platens on which operators may be burned.

High frequency heating is particularly adaptable to aircraft wood work because of the light weight or low specific gravity of these parts. In shop terms, light weight parts usually require large factory space while the glue is drying, plus many large clamps to hold the parts in place for hours at a time. On the other hand, most airplane parts or units are very light in weight. The electricity required for heating any product is directly proportionate to its weight and specific heat. This increases the advantages for aircraft production, since heating with this equipment does not require big units to do the large production jobs.

Use of high frequency electricity is a very efficient means of heating nonmetallic parts—the average wooden parts being heated at efficiencies ranging above 50 percent of the electrical line input. Compare this with the heating efficiency in electric ovens, where radiant heat from infra-red lamps or resistance grids is used, with efficiency of heating nonmetallic parts in the neighborhood of 10 percent. Further, such heat is applied to the surface and not through the whole piece, which still further lowers effectiveness. Considering that high frequency equipment costs only from a fraction of a cent in some localities to three cents per kw-hr to operate, it can be understood why the process is economical.

Another advantage is the direct application of electrical field heating to most existing equipment. New presses are not required, and there is no obsolescence of equipment when it is applied

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READ WHAT PRODUCTION MEN SAY

"Eighty instead of former twenty on set-up wheels."
Large metal battery cases for the Navy.

"Greatly increased production and definitely better finish."
Grinding the welds and putting a radius on corners of stamped steel cartridge boxes.

"More than five times former production."
Removing outside flash from parachute hardware.

"Over five times the former output from set-up wheels."
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You can easily see why a change-over from set-up wheels to Idler Backstands and Metalite Cloth belts has vastly increased and improved metal grinding and polishing output in many war industries.

Among the numerous advantages we list but a few.

Controlled coating of modern abrasive cloth
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The process is also very versatile. If the operating cycle were 20 min. for each loading, then one heating unit could be connected to three presses (Fig. 12), and each press could be loaded in rotation. This would utilize the heating equipment to maximum efficiency.

Calculating Capacity

Calculating the capacity or size of the heating unit required is very simple. The heat balance equation is determined from the weight of the parts to be heated, their specific heat and the temperature rise required. The material is placed between two electrodes, which are connected by two wires to the heating unit. In some presses it is convenient to ground the machine to one side of the heating unit and slip the hot electrode in the middle of material stack (Fig. 8).

The formula for calculations is expressed as follows:

BTU required = Wt. of wood (in lb.) x Specific Heat x Temperature Rise (in deg. F.)

To raise the temperature to 170 deg., taking the average specific heat of wood at 0.45, the BTU's required for 1 lb. of wood is derived thus:

1 lb. x 0.45 x 170 deg. — 80 deg. (req. temp. — room temp.) = 40.5 BTU's per lb.

Note that this temperature range is below the boiling point of water so that the latent heat of evaporation is not reached and, therefore, no BTU's are wasted. The wood and moisture content are raised only within the sensible heat range, thus thousands of BTU's required to evaporate the moisture are saved.

Now suppose we have 10 pieces weighing 1½ lb. each to heat up in each press load. The weight will be 15 lb. per load. 15 x 40.5 BTU's per pound = 607.5 BTU's per load. We know that the efficiency of electrical field heating is at least 50 percent. Hence, if 607.5 BTU's are required per load twice that many must be supplied to the heating unit or 1215 BTU's.

One kilowatt of electric energy per hour delivers 3413 BTU's per hour. Therefore, if one kw. is delivered to the heating unit and only 1215 BTU's are required, only 1215/3413 x 60 min. = 21 min. heating time is required per load. Two kw. would halve this time and three kw. would reduce it to seven minutes.

Thus it is easy to adjust the loads to the electrical field heating unit or vice versa so as to get the most economical handling rate. Once determined, it is not even necessary for the operator to know anything except the setting for each type and weight of load.

Automatic tuning devices can be provided so that it is not even necessary

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for the operator to watch the machine once a load has been put in the press and the heater started. This conserves labor time and eliminates errors of personal judgment.

Application of electrical field heating to aircraft fabrication offers possibilities in time saving in the gluing of parts that have never been realized by any other method in the past. The process invites careful investigation by farsighted production men who can visualize the possibilities of wood as a present and future material for spars, ribs, and fuselages of airplanes.

Intercoolers in Aircraft

(*Continued from page* 129)

characteristics of tested units. A mathematical proof can be derived by considering that a film coefficient will be equal to a constant times the weight flow to some exponential power. This makes it possible to differentiate the equation with respect to weight flow and gives the slope of this line directly even though the differentiated expression is complex. It is a definite proof of constant effectiveness with a mass ratio of 1 and shows that for high mass ratios the negative slope is less than 1 percent. The usefulness of this law of constant effectiveness is in checking performance charts and in extending their field by means of a rational method of extrapolation.

The general trend in intercooler design with the advent of higher horsepower engines has been a steady increase in effectiveness per unit volume. The effectiveness of four intercooler types is shown (Fig. 2), all of the same over-all dimensions, at a standard air pressure drop (Δp) on the coolant air of 4 in. H_2O, and ranging over an engine air flow from 50 to 150 lb per min. The total effectiveness range spanned by the four types is seen to cover an effectiveness value from 50 percent for Type A to 90 percent for Type D. The relative coolant air consumption is shown with Type A taken as 100 percent.

Type A is a round tube unit. The effectiveness at an engine air flow of 130 lb per min is 52.7 percent, and the pressure drop for this flow is 9.4 in. H_2O. Types B and C are of the flattened tube type and are of interest because of the fact that Type C, which has a higher effectiveness than type B, actually has 8 percent less surface than type B and uses 24 percent less coolant air. The increased performance is obtained solely by an increased engine air pressure drop which has risen from 6.4 in. H_2O to 17.5 in. H_2O at a flow of 130 lb per min (approx. 275 percent).

In Type D the surface has been in-

creased still further than in Type B. At an engine air flow of 130 lb. per min., we find the effectiveness to be 72.7 percent, an increase of approximately 38 percent over that of Type A and a pressure drop of 23.3 in. H_2O, which corresponds to an increase of approximately 250 percent.

The curves of Fig. 2 show the trend in design. They do not immediately show whether this trend is correct. In order to examine this phase of the development, Types B, C, and D have been applied to the same problem on a specific airplane and the required power has been calculated for the problem point while the dimensions of the units were varied.

Figs. 3 and 4 show the power consumption for Types B and C, that is, the power consumption on the coolant air side, the engine air side, and the power required to carry the weight of the intercooler and also a curve showing the addition of these three items. (For simplicity no credit for the Meredith effect has been considered.*)

The dimension in the direction of coolant air flow has been held constant and the no-flow and engine air length has been varied in both directions from unit values. The full curves refer to the variation in engine air length and the dotted curves show variation in no-flow length. At the problem point, Type B is seen to consume 21 hp. and Type C, 22 hp. when both of unit length, that is, as actually built and installed on the plane.

An examination of the curves shows that a decrease in no-flow and engine air dimension is associated with an increase in total power, while an increase in both these lengths causes a decrease in total power until a definite minimum has been reached in a size considerably larger than the original unit. It is to be noted here in passing that no increase in duct weight has been added to the weight of the cooler, that is, the weight curve is somewhat low. A correction on this item would cause the point of minimum power to be reached somewhat earlier.

It is seen that the greatest reduction in power is obtained by increasing the no-flow dimension. In the case of Type C, it is noted that very little power reduction is obtained by increasing the engine air length. The corresponding power curve is practically at a minimum at unit length; that is, the unit as designed is of correct engine air length. However, by increasing the no-flow dimension, a considerable saving in power is possible. The total power at 1.75 times actual size is only 13 hp., that is, a saving of 9 hp. per unit is possible.

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* Roucher and Phillips, *Journal of Aeronautical Sciences*, Feb. 1941

In the case of Type B, apparently some power reduction is possible with an increased engine air length. The total power continues to fall off until an engine air length of 1.5 times unity has been reached. The total power curve for an increase in no-flow, therefore, could have been lowered if the original unit had been designed with a greater engine air length. This is consistent with the fact that Type B only reaches a minimum of 14 hp as compared to the 13 hp for Type C, although the original power consumption at unit length was less. Both units, however, show that the real reduction in power is obtained by an increase in no-flow direction. The engine air dimension may be varied widely and even decreased with little effect. This is particularly true when the engine air pressure drop is high.

This lesson has been learned in Type D on Fig. 5, where unit length of the engine air is 65 percent of the unit length of Type B and C and the no-flow length is 60 percent greater than the B and C dimension; also the coolant air dimension has been reduced to 75 percent of the coolant air dimension in Types B and C. The total power at the problem point is, consequently, less than in the case of B and C, namely 18 hp. The total power curve shows that a reduction to 11.5 hp is possible by a still further increased no-flow dimension. An increase in engine air dimension is of little value, since the problem point at unit length is just to the left of the flat part of this curve.

Fig. 5 also shows a power curve for Type D in the same original dimensions as Types B and C, that is, with its engine air length increased and its no-flow dimension reduced. Since an increase in engine air length has little effect and a decrease in no-flow a great effect, we naturally obtain a considerably increased power curve which, it is seen, comes to a minimum at about 16 hp and consumes 24 hp at unit length dimensions.

A comparison of the three types shows that, all in all, the power consumption for the various units of same dimensions are roughly the same. The higher effectiveness unit requires a slightly higher power consumption than the lower efficiency units, consistent with higher pressure drops in the high effectiveness units. In other words, if a given cooling is to be accomplished in a given space, it appears that the power consumption is of a predetermined value irrespective of the type of core installed.

A considerable power saving, as much as 35 to 40 percent, can be obtained by an increase in the no-flow dimension of 75 percent. The trend to keep the dimensions down to the bare minimum is therefore, not correct and a careful study of the power consumption is recommended for each installation before intercooler dimensions are fixed. A reasonable weight increase in such a unit is associated with lower power consumption and, therefore, lower fuel consumption and greater flying range.

A few points may be flagged to illustrate the interest attached to the problem and the need for painstaking attention to the intercooler specification. Once the designer has fixed his critical altitude and chosen his supercharger, the temperature-pressure relation required at the discharge of the engine air stream from the intercooler is known. This relationship can be met with a series of intercoolers and the selection may well hinge on the space available. Among different criteria for the selection would be the total horsepower required to pass the two air streams through the system and to fly the weight of the intercooler and its supporting surface, with proper credit for the Meredith effect. This might be of major import on a long range ship. While the horsepower is not of a large order, it has been found that substan-

tial reductions can be made at the expense of weight and space.

This brings up the question of weight. And as for the intercooler itself, the weight is of little importance, except insofar as it affects the weight of the ship at takeoff, its drag in flight, and its wing loading. If slightly additional space were available on one of our long range planes, the saving in weight of fuel accomplished by the more efficient intercooler size would exceed the increased weight of the unit. Hence, for a given mission the takeoff weight would be fractionally reduced. The result would be measurably increased power available for flight.

Evidently even weight has to be "weighed". This subject is ably presented by U. T. Joyner, of the NACA, and warrants detailed study. The use of heat transfer formulas in calculating performance is of value in studying the basic design. For approximating performance under turbulent flow conditions, we require three sets of equations, one for each zone (turbulent, buffer, and boundary). The mathematical complications render analysis of this character quite tedious. For actual installation and intercooler selection, only laboratory test data are of sufficient accuracy. It must be remembered that an error of only 1 percent may bring on detonation at the critical altitude. Since aircraft installations can seldom give the same distribution that is obtainable in the laboratory, it is desirable to run wind tunnel tests on sections of the structure housing the system.

One tempting field for development is in the use of aftercoolers. Here more severe conditions will exist due to the presence of fuel vapor, higher pressures, and greater stresses under backfire. Nonetheless, high temperature differences are present and reduced takeoff temperatures could be realized, of great value under hot weather operation.

More attention should be given to the coolant stream exit, where the use of automatic exit flaps is of interest because of control of carburetor icing in flight and a resultant decrease in drag, except under maximum design duty. The advantages will bring with them some increase in weight and in complication.

Due to necessary restrictions, this paper has been of a superficial character. Perhaps, however, we have gained some measure of appreciation of the problem and its interesting complexities and have realized the necessity for continued research in this field. One thing seems clear—no government ceiling will be placed on altitude, and the demand will be active.

How to Fair Lines

(*Continued from page* 139)

as

$$mx + h = \pm\sqrt{H^2 + 2Am}$$

therefore

$$y = mx + h = \pm\sqrt{h^2 + 2Am}$$

It must be remembered that y is a value of dy/dx, and since dx/dy is desired, the y value must be reciprocated. That is—

$$\frac{dx}{dy} = \frac{1}{\frac{dy}{dx}} = \frac{1}{y}$$

Three or four dx/dy values determined from the dy/dx curve should be sufficient for spacing the two curves together. Additional dx/dy values should be determined from the original curve by using the special protractor as shown in Fig. 8.

The dx/dy values are plotted in a similar manner as were the dy/dx values, i.e., the dx/dy values are plotted to a greatly expanded scale, but against a base axis scale which is the same as that for the original curve.

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The dx/dy curve is now faired through these points keeping in mind the same points as for the dy/dx curve. Note that the dx/dy curve crosses the Y axis at an angle.

It is necessary to obtain an offset from the dy/dx curve for one of the integer vertical axis stations to tie the offsets obtained from the dx/dy curve to those obtained from the dy/dx curve. This ordinate serves as a starting point for the offsets determined from dx/dy. Referring to Fig. 10, it can be seen that $q-x$ represents the offset we desire. From the equation above

$$x = \frac{j - h}{m}$$

Then, as has been stated:

Splicing offset tying dx/dy to dy/dx = $q-x$

Integrating dx/dy Curve

The dx/dy curve is integrated in the same manner as the dy/dx curve. The integration has been explained in our Third Step (See page 350, Jan. AVIATION).

It must be remembered that for the dx/dy curve, the vertical axis serves as the base, and the area contained between the dx/dy curve and the vertical axis base is equal to a difference of vertical axis station offsets (See Fig. 12).

Obtaining horizontal axis station offsets from the dx/dy curve

The same principles are used in the solution of this problem as were used in determining vertical axis station offsets from the dy/dx curve. Refer to Fig. 11 for the following explanation:

The horizontal axis station is the one determined by f'. (It need not be a whole dimensioned horizontal axis station unless the station is to be used in splicing.) Determine station p' and station q' such that the desired offset is included between them, and such that a straight line assumed for the dx/dy curve between these stations will subtend negligible areas of A and B shown in Fig. 7.

Then the following can be seen:

dy/dx of sta. $f' = 1/j'$

Area $A' = f' - \delta'$

Slope of assumed straight line =

$$m' = \frac{k' - h'}{q' - p'}$$

Offset of sta. $f' = p' + x'$

$j' = m'x' + h'$

The area designated as A' can be expressed:

$$A' = h'x' + \frac{m'x'^2}{2}$$

or, solving for x'. . .

$$x' = \frac{-h' \pm \sqrt{h'^2 + 2A'm'}}{m'}$$

Then, as has been stated:

Offset of sta. $f' = p' + x'$

and

dy/dx of sta. $f' = 1/j'$

Thus, horizontal axis station offsets and horizontal axis station dy/dx values can be readily determined from the dx/dy curve.

The question of accuracy of the procedure naturally comes up. In assuming the straight lines for portions of the first derivative curves, the error is negligible, since the areas A and B can be estimated with surprising accuracy, and in most cases the first derivative curve is so flat that the assumed straight line is practically coincident with the curve. Any error that is introduced by the straight line is of the compensating type and as such does not build up to an inaccuracy of any importance.

Shrinkage and growth of the graph paper does not introduce an error, since the scales used shrink and grow with the graph paper.

Graphical calculus can be applied to any undefined curve, and it gives a resultant which is very fine for splicing purposes. Curves developed by the graphical calculus can be faired into any

defined mathematical curve by merely plotting the first derivative of the known curve and spheing the calculus curve to it This procedure has been used quite successfully in "tumble-home" conditions

It is interesting to observe how analytical the first derivation curve is of the original curve A little study of the first derivative curve gives facts about the original curve which were never available before.

This concludes the series by Mr Madsen on Fairing Lines

New Production Role

(*Continued from page 95*)

Personnel directors report that they are scraping the bottom of the barrel on manpower, so the vast majority of the new workers will be women In fact, nearly 80 percent of all new employees at several plants for the last four months have been women And Canada, it should be noted, has never had a reservoir of experienced aircraft workers on which to draw

At the Malton airport is situated one of the most modern aircraft plants in the world. Here the twin-engine *Anson* transitional trainers, have been coming off the assembly line at the rate of around 18 a week. At the same time the plant has been tooled up recently for the powerful four engine *Lancaster*. This was a logical selection, since this plant, built and expanded with private capital, is the only one in Canada large enough to make these giants of the air with their 102-ft. wing spread, bomb carrying capacity of eight tons, and maximum flying range of 3,000 mi They are powered by 1,250 hp Packard-built Rolls Royce engines, as are the Canadian-built *Hurricane* fighters and *Mosquito* bombers.

Nearly 5,000 are employed at Malton now, including close to 1,000 women. Within another three or four months, when the big bombers come down the assembly lines, laid out in three huge bays, the payrolls probably will be up to 8,000 But that won't necessarily be the peak, as present orders may be tripled "The *Lancaster*," as Plant Manager Dave Boyd puts it, "is bound to be a good bomber for the duration."

Rivaling the big *Lancaster* in public interest is the *Mosquito*, which raided Berlin at 11 a.m. on the 10th anniversary of the Nazis' accession to power, and which is rated as one of the swiftest, most deadly aircraft in the world. This combination fighter-bomber-reconnaissance plane is produced by deHavilland, formerly makers of the *Tiger Moth* trainer, which has been built in larger numbers than any other aircraft produced in Canada.

The *Mosquito*, in a recent test at Ottawa, amazed the writer with its speed and maneuverability. It flies so fast that it appears to keep ahead of the sound of its motors Although made of plywood, it is classed as one of the strongest and toughest military aircraft now in use.

In the Ottawa test the pilot, Geoffrey deHavilland, son of the firm's founder, after a short run along the ground pointed the *Mosquito* almost straight up and was lost in the sky in a few seconds A moment later he came down in a terrifying dive and shot across the field at astounding speed All sorts of maneuvers followed, and the plane seemed to do almost as well with one engine as it did with both They are Packard-built *Merlins*

The *Mosquito* requires fewer man hours of labor than any other two-engine bomber and, because of its wooden construction, conserves light alloys and other strategic materials In fact, the production of this plane currently places Canada somewhat ahead of the United States with respect to the use of wood in combat planes America, now building plywood training planes, soon will

be in production on wooden cargo planes but has not, as yet, gone into large-scale production on wooden combat units.

Canada has set up two crown companies for the single purpose of developing new sources of aircraft woods and conserving existing supplies. It is no wonder that these supply conservation measures have been deemed necessary, for Canada eventually expects to be the most important producer of the *Mosquito*, a plane that has outflown in action Germany's best fighting plane, the Focke-Wulf 190. DeHavilland had two planes of this type in the air late in 1942. Production probably will be well advanced by mid-year.

In connection with plywood, it should be recorded that the new *Anson 5*, a bombing, gunnery, and radio trainer, is largely of wood construction to simplify construction and save strategic materials. The *Ansons*, with a plastic nose, have used a substantial amount of wood from the beginning and now have both the fuselage and wings made of wood. The *Anson* runs a close second to the Tiger Moth in the total number of planes turned out in Canada.

One of the most pressing aircraft needs of the United Nations, particularly Great Britain, has been dive bombers. In order to help remedy that situation, two prominent Canadian aircraft concerns have been selected to concentrate on the Curtiss *Helldiver*. Canadian Car & Foundry will divert its main production from *Hurricanes* to the Curtiss plane within the next few months, while Fairchild likewise shortly will be turning out the dive bomber to supplement the several plants in the United States at work on that design.

Canadian Car has doubled its plant space at Fort William while tooling up for the Curtiss job and is increasing its plant force from 5,000 to around 7,000 for the new assignment. Other plants of this company, which make propellers and a variety of munitions outside the aircraft line will be brought in on the Curtiss contract which according to the original announcement, called for a maximum output of 80 planes a month. The order covered more than 1,000 planes at a cost of $40,000,000 and was calculated to keep both the Fort William and the greater part of the Pointe St. Charles plants of Canadian Car fully engaged until late in 1944.

Fairchild Aircraft is building a long nose version of the Bristol *Blenheim*, also a twin engine combination operational and training bomber. At the same time the company is doubling its plant capacity in preparation for making the *Helldiver*. Fairchild, along with National Steel Car, Canadian Car, and Noorduyn, has produced the lion's share of the nearly 7,000 aircraft produced in Canada since war broke out.

Canadian Vickers and Boeing Aircraft of Canada are producing the Consolidated PBY *Catalina*, long range coastal reconnaissance amphibian which is able to stay aloft for more than 33 hr. While not a new plane, it has the record range for any craft of its type and is indispensable as a watch-dog of the seas. Vickers, which lead the revival of Canada's aircraft industry back in the 1920's, also produced the *Stranraer* flying boat for patrol work off the Canadian coast earlier in the war. Up to now the company has been making most of its aircraft right in its shipyard, although final assembly work and some parts have been handled at other plants.

Noorduyn Aircraft has the distinction of building the only plane now in production that is of strictly Canadian design—the *Norseman*—which has proved an excellent ship for radio training and which, in a newer version is on order from the United States for light cargo purposes in the northland. Known as the "flying one-ton truck",

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is rugged all-purpose plane with a 1,250-mi range is especially adapted for the rigors of the north country when equipped with skis or pontoons.

Bob Noorduyn, reared on a Vermont farm, came to Canada nearly eight years ago, built up the nucleus of a first-class production organization based on his experience as a manufacturer in the States, when the opportunity came, did a prime production job for the Dominion with his version of North American's *Harvard* trainer.

Fleet Aircraft, Ltd., at Fort Erie, on the other hand, is building the low-wing *Cornell* primary trainer, the Canadian version of the Fairchild PT 19 and the successor to the famous *Tiger Moth*.

Scores of other Canadian companies, most of them outside the strictly aircraft group, are contributing their bit along with the primary producers to bring the industry into hard hitting maturity. Farm implement firms, such as Massey-Harris Company, Ltd., Cockshutt Plow Co., Ltd., and Dominion Oilcloth & Linoleum Co., Ltd., are among those making wings, ailerons, flaps, landing gears, and engine components. Other manufacturers are engaged in the overhaul and repair of aircraft. This business alone has mushroomed to the point where its volume is greater than the pre-war business of Canada's motor car manufacturers.

And last but not least, Canadian aircraft officials attribute much of their success in overcoming what appeared to be insurmountable difficulties to the aggressive leadership and vision of Ralph Bell, director of the Canadian aircraft program. He is the Canadian counterpart of Charles E. Wilson, new director of the United States air production program and, like Wilson, his specialty is getting things done.

Regulatory Stability

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Here can be seen another practice which the air carriers can and should best avoid.

While a certain amount of discussion will continue as to the basis and method of mail compensation to be applied for the air carriers, considerable progress has now been made in this direction. As evidenced by the record—through the absence of serious objections—the majority of the carriers appear to be willing to go along with the board's present theories on compensation for the transportation of the mail.

Less unanimous and coming in for special attention at this time is the question of passenger fares to be charged by the air transport operators. The board has repeatedly indicated that it would prefer that the carriers reduce passenger tariffs and take this action voluntarily. In the Eastern decision, the board officially specifically noted that the matter of passenger rates should receive early consideration. This same sentiment was repeated in the American and other subsequent mail rate actions.

This passenger fare question raises many interesting problems. The elimination of discounts on scrip and round-trip fares, effective July 1, 1942, resulted in an increase of approximately 10 percent over the tariffs formerly in effect for the majority of the lines. At that time, the outlook for airline revenues was such that this action appeared justified. Actual results, however, have given the air carriers the best earnings in their history and from this standpoint alone the fare increases of last summer are difficult to justify.

Common impression is that the average passenger fare for the airlines is around 5c per mile. The CAB in its annual report indicates the average fare at 5.05c per mile for the fiscal year ended June 30, 1942. But while this

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average figure is correct it is also misleading There is considerable variation in the passenger tariffs among the separate carriers For example by examining the air mail rate decisions as recently released by the CAB, the current fares for the individual carriers are clearly indicated These present estimated fares (per passenger mile) as follows:

American	5 50c	Eastern	5 75c
Braniff	5 13c	National	5 27c
Chic & Southern	5 02c	PCA	6 12c
Colonial	5 83c	TWA	5 47c
Delta	4 94c	United	5 47c
		Western	5 40c

It can be seen that among the domestic lines, fares range from a low of 4 94c for Delta to a high of 6 12c for PCA Hawaiian, at the apparent urging of the board reduced its average passenger fares from 9 26c to about 8.00c per mile In any event, these differences in passenger fares among the various lines show that it is incorrect to apply the average passenger fare as representative for all airlines

Pan American Airways and Panagra have indicated that, effective Mar 15, passenger fares will be reduced by about 10 percent on all Latin American routes While the announcement came from Pan American with the impression that these reductions were entirely voluntary on the part of the carriers, the indications are that this action was inspired by active prompting on the part of the CAB Regardless how motivated these reductions will not only benefit present travelers but is indicative of things to come in the postwar era.

Domestic airlines may voluntarily, or by board fiat, order reduced passenger tariffs This will be nothing more than a continuation of the trend that has been in progress since the inception of air transportation According to the Air Transport Association of America average passenger fares (per passenger mile) for the industry have shown the following conse

1926	12 0c.	1934	5.9c
1927	10 6c.	1935	5 7c
1928	11 0c	1936	5 7c
1929	12 0c	1937	5 6c
1930	8 5c.	1938	5 7c
1931	6.7c.	1939	5 1c
1932	6.1c.	1940	5 0c
1933	6.1c	1941	5 0c.

The normal trend has been towards lower fares in any event and its only a question of time before this downward course is resumed History of all transportation clearly shows that improved technologies constantly make for improved service, lower costs, and benc lower tariffs.

For example, the railroad industry in 1921, received an average of 3 086c per passenger mile from all classes of passenger travel By 1941, this average rate had declined to 1 753c per passenger mile, or almost by 50 percent from the levels prevailing in 1921. Further, the railroad industry has shown no indication of not being able to effect still further reductions in passenger charges

Railroad experience once again highlights the potential market available to the air carriers It is only by a reduction in fares that the airlines will be able to tap any appreciable share of passenger railroad travel According to the Interstate Commerce Commission for the ten months ended Oct. 31, 1942 the average revenue per passenger mile for the country's railroads was 1 77c for coach business and 2 41c for parlor and sleeping car traffic These are the rate levels the airlines will have to approach in order to materially increase their volume once they are in position to make the attempt

Improved Ground Instruction

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other parts and accessories, preferably in working order, will be found most helpful Fig 2, shows a carburetor assembly mock-up, revealing the inner working of this important accessory.

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the mechanism, floats, pump, etc. The use of a colored liquid and glass tubing further increases the impressiveness of the demonstration. Electrical systems and wiring diagrams are clearly illustrated by wired units as shown in Fig 3.

In meteorology, which is devoted more or less entirely to the training of pilots, cross sections of the atmosphere drawn in bright colors on large posters (see Fig 4), uncased barometers showing the entire mechanism of the pressure indicating instrument, and many other items, can be used to advantage.

Study of navigation is especially aided by practice with mock-ups, for it is a subject which cannot be learned entirely in the classroom. The principles can be taught, but the finished pilot is one who has repeatedly worked the problems under actual flying conditions. To get as near as possible to the problems which the student will meet in the air, we have devised a board at this school (Fig. 5) on which many problems of air work can be solved. The various navigation instruments such as altimeter, compass, clock, air speed, and drift indicators, are made with movable hands. They are set by the instructor as the students work actual flight problems on their maps. Value of this piece of equipment lies in the fact that it makes the student observe all instruments continuously—a snag in the early training in navigation.

For use in conjunction with this board, a sound effect has been devised which reproduces the continuous drone of the engine. Through the working of the problem, the monotonous hum of the "engine" is heard, thus making the student work involved problems under service conditions.

Intricacies of map making are usually perplexing to a student, and to demonstrate the principles involved in various types of map projections, a transparent globe of pyralin is used which enables the student to see the procedure. An electric bulb at the center of the globe shines through projecting clear unpainted lines representing the parallels and meridians on paper, showing their developments on plane surfaces, cones, and cylinders.

For training in aircraft instruments, complete panels of both navigation and engine instruments should be included, permitting radio direction finding, drift, and other flight problems to be demonstrated. Familiarity with the complicated mechanism of the automatic pilot is furnished by the set-up shown in Fig 6.

For teaching the flight student proper airport traffic patterns, the use of visual signals, proper use of runways and other pertinent airport procedure, nothing can be more helpful than a model airport (Fig 7) with runways, danger areas, and other important factors which the student will encounter in his daily flying. Lighted runways also help in teaching use of the field during night flying operations, with caution lights, landing lights, markers, etc.

While these mock-ups are a small part of the number that could be devised by a ground school, it is hoped that they may offer suggestions for increasing the efficiency of pilot and mechanic training.

11th Annual Meeting

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ton miles or by ton hours per ship per day—Capt. William M. Masland (Pan American Airways) said in his analysis titled *Developing Maximum Efficiency in the Operation of Long Range Air Transports*. But there are also snares in the way of the best laid courses—the limited or dirty hours of a crew, the fact that some ports can be used only during daylight, and eternally the weather.

Defining low altitude flying as less

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than 20,000 ft, Charles W. Morris (Airesearch Manufacturing Co.) advocated a different method of adjusting cabin air pressures for passengers' comfort. Instead of an attempt to maintain sea level pressure, there should be a gradual adjustment to the pressure at the point of destination. For example, on a flight from San Francisco to Reno, compensation must be made for a four pound drop crossing the mountains and then a two pound rise on landing. But if cabin air were adjusted to the pressure at Reno, there would be only a two pound variation. The energy required by pressurizing and air conditioning apparatus to make such an adjustment is about ¾ hp per passenger.

Other papers presented to the Design and Transport sessions:

Albert A. Arnhym (Pacific Airmax Corp.), *Comfortization of Military Aircraft*

Roland J. White (Curtiss-Wright Corp.), *A New Method of Longitudinal Control for Aircraft by Use of an Adjustable Angle of Attack Balance.*

Horace J. Alter, *Passive Defense—The Protective Armoring of Military Aircraft*

Materials

Three different methods of strengthening metals were outlined in papers on *Design-Strengthened Sheet Metal* by Richard S. Smith (Rigid-Tex Corp.) and Hamilton Gray (New York University); *Thin Case Hardening with Radio Frequency Energy* by V. W. Sherman (Federal Telephone and Radio Corp.); and *Mechanical Properties of Austenitic Stainless Steels* by R. A. Lincoln and W. H. Mather (Allegheny-Ludlum Steel Corp.).

Mr. Sherman explained a process by which cylinders and bolt holes can be case hardened without distortion after they have been finished to required dimensions. A 5 to 15 megacycle current, applied so that the heat on the surface is double (or more than double) that reaching the core, produces a hardening .005 to .030 in.

A survey of elevated temperature aging of 24S aluminum alloy was presented by Paul P. Mozley (Lockheed), who pointed out that this material can be set with an allowance of 1 percent for stretch. Each rise of 25 degrees aging time in half; 375 deg. gives the highest production yield and results in satisfactory aging in six to seven hours.

Magnesium—heat treated forged and cast—composes 10 percent of the material going into German aircraft, according to H. W. Schmidt, whose paper was extensively illustrated with photographs of fuselage and engine parts taken from fallen Messerschmitt and Junkers ships.

The final paper prepared for the Materials session was by A. U. Kutsay and A. J. Yorgiadis (Pennsylvania State College) *On the Torsional Damping Capacity of Solid Magnesium Alloy Rods as Affected by Cold-Working.*

Meteorology

For a more exact measurement of humidity than can be obtained by the psychrometer, L. W. Foskett and H. B. Foster (Instrument Division, U. S. Weather Bureau) described a spectrophotometric hygrometer which has been built for the Bureau. With this instrument, the ratios of spectral intensity of lines of water are compared photometrically. The device's only drawback, in the opinion of some listeners, seemed to be the complications and cost of construction which might prevent its being widely used. . . . The results of an important five-year study were presented in a paper on *Lightning Phenomena* by G. D. McCann (Westinghouse Electric & Mfg. Co.). He described extensive research work in analyzing the nature of lightning bolts and measuring field distribution in thunderclouds and the ground gradient beneath them as well as calculating the voltages of bolts and

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their affect on power transmission systems.

In *Cloudiness and Precipitation in Relation to Convergence*, James M. Austin (Massachusetts Institute of Technology) analyzed the most frequent reasons for faulty weather predictions.

Two scientists connected with Harvard University's Blue Hill Observatory, Charles F. Brooks and S. P. Fergusson, read papers on, respectively, *Non Instrumental Determinations on the Ground of Ceiling, Icing Layers, Turbulence, and Winds Aloft*, and *Gustiness Under Various Weather Conditions*. Mr. Brooks offered some hints for ascertaining velocity and turbulence without the use of complicated instruments, while Mr. Fergusson outlined ways to measure irregular wind shifts.

Other papers presented to the Meterology session:

C. E. Buell (American Airlines), *Determination of Vertical Velocities in Thunderstorms*.

Robert D. Fletcher (U. S. Weather Bureau), *Applications of the Vertical Shear Vector to Upper Air Analysis*.

Physiologic Problems

Chief point brought out in this forum was the need for collaboration among physicians, designers, and experienced pilots. Suggestions on immediate conditions which designers should consider were made in a paper on *Vision, Hearing and Aeronautical Design* prepared by L. D. Carson (Medical Research Section, Bureau of Aeronautics, U. S. Navy), Walter Miles (Yale University Medical School) and S. S. Stevens (Harvard). Dr. Carson, who read the article, pointed out that the main task was the diminution of eye and ear strain upon pilots. This can be accomplished by eliminating structural work interseeting the line of vision and reducing engine noises as much as possible.

What the services are actually doing in aviation medicine was outlined in two other papers, *Medical Activities in Naval Aviation* by James C. Adams, Bertram Groesbeck, Jr., and Eugene F. DuBois (U. S. Navy Bureau of Medicine and Surgery) and *Medical Activities in Military Aviation* by Otis O. Benson, David B. Dill, and W. Randolph Lovelace (U. S. Army Aero Medical Research Laboratory, Wright Field). At the request of Pres. Dryden and Vice-Pres. Gardner, Dr. DuBois attended the latter part of the simultaneous meeting on aerodynamics and again described body factors which most designers must consider.

Other papers presented to the session on Physiologic Problems:

Louis H. Newburgh (University of Michigan), L. P. Herrington (John B. Pierce Laboratory of Hygiene), and A. P. Gagge (Army Aero Research Laboratory), *Limits of Human Heat Regulation*.

Datley W. Bronk (University of Pennsylvania), E. G. Hall (Royal Canadian Air Force), and Eaton MacKay (Scripps Metabolic Clinic), *Oxygen Requirements and Equipment in Aviation*.

William E. Russell (Boeing Aircraft Co.), F. E. Poole (Lockheed), and Hugh DeHaven (Cornell University Medical College), *Medical Research in Some Aspects of Aircraft Design*.

Power Plants and Propellers

Results of a *Study of Exhaust Valve Design From the Gas Flow Standpoint* were presented by Seng-chiu Hu (United Aircraft Corp.). He found that the flow of coefficient varies only slightly with pressure changes, and that the loss of energy from blow-downs could not be put to any use. The 30 deg. valve gives the best air flow at low lifts and the 45 deg. at high ones. The simple alteration of rounding the exit and valve approaches increased energy as much as 25 percent.

Manifold temperature rather than turbine speed limits the effect of supercharging, according to a paper on *Temperature Effects on Turbine Supercharger Installations* by Philip Colman (Lockheed). Even with supercharging, horsepower output levels off after a plane reaches 20,000 ft., and loss of power may approach 35 percent on a hot day as contrasted to a cold one.

A simplified calculating machine method for estimating bending stresses in a moving propeller was described and advocated for general adoption in the industry by Joseph Stuart, III (Aeroproducts Division, General Motors) in a paper entitled *A Tabular Method of Propeller Blade Stress Analysis*.

Other papers presented to the Power Plants and Propellers session:

John Markell, Jr. (Massachusetts Institute of Technology), *The Volumetric Efficiency of an Internal Combustion Engine*.

J. C. Luttrell (Army Air Transport Command) and W. A. Petrasek (American Airlines), *The Horsepower Meter for Aircraft*.

Jere T. Farrah (American Airlines), *Problems of Routine Propeller Balancing*.

Radio and Instruments

A new automatic device, the Vultee radio recorder, which registers temperatures, pressures, strains, and stresses (up to 100 signals a second on paper and transmits them automatically by frequency modulation, was explained by Harvey D. Giffen (Vultee Aircraft) Charles H. Colvin (New York University) described an altimeter setting indicator which can easily be used in connection with any altimeter. An electrical instrument, the Pioneer Magnesyn Remote Reading Compass, solving the problem of reading a compass placed in a remote part of the plane to reduce deviation, was demonstrated by Donald W. Smith (Pioneer Instrument Division, Bendix Aviation Corp.).

Other papers presented to the Radio and Instruments session were:

David W. Moore, Jr. (Fairchild Aviation Corp.), *Resonant Electrical Control Systems*.

K. J. DeJuhasz (Pennsylvania State College), *Graphical Analysis of Delay of Response in Airspeed Indicators*.

Paul J. Campbell (United Aircraft Corp.), *A Multiple Recording Manometer*.

Rotating Wing Aircraft

Because of wartime censorship much was left unsaid at the fifth annual session on this subject, but considerable important information on developments of the helicopter was given by leaders in the field, notably Igor Sikorsky (United Aircraft), who commented on *Progress of the Vought-Sikorsky Helicopter Program in 1942*, and E. Burke Wilford (Pennsylvania Aircraft Syndicate, Ltd), whose subject was *Control for Helicopter Rotor*. Three other papers preceded these addresses. The use of vertical wind tunnels in predicting helicopter performance was analyzed by W. F. Gerhardt (Army Air Transport Command) in a paper on *Helicopter Model Engineering—Its Relationship to the Development and Utilization of Military and Commercial Helicopters*. Theoretical problems were also considered by Quentin Wald and Charles H. Kaman (United Aircraft Corp.) in respective papers on *A Method for Rapid Estimation of Helicopter Performance* and *Aerodynamic Considerations of Rotors in Havering and Vertical Climb Conditions*.

At the Detroit meeting, Prof. F. N. M. Brown (Notre Dame University) showed an unscheduled motion picture on the behavior of air foils made photogenic with titanium tetrachloride exuded through home made equipment.

Structures

The conduct of flutter tests on models and the equipment used for calculating stresses on ships the size of the *Mars* were described by William B. Bergen (Glenn L. Martin Co.) in a paper on *Experimental Investigations in Aircraft Dynamics*.

Other papers submitted to the Structures session were:

D. S. Wolford (The American Roll-

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ing Mill Co.), *Significance of the Secant and Tangent Moduli of Elasticity in Structural Design.*

N. J. Hoff (Polytechnic Institute of Brooklyn), *General Instability of Monocoque Cylinders.*

Richard K. Koegler and Arthur Schmitt (Curtiss-Wright), *Effects of Yielding and Perforations on a Wing Tension Surface*

Paul H. Denke (Douglas), *Strain Energy Analysis of Incomplete Tension Field Web-Stiffener Combinations*

Frank P. Cozzone (Lockheed), *Form Factors for Metal Parts*

Henry L. Langhaar (Consolidated Aircraft Corp.), *Buckling of Aluminum-Alloy Columns and Plates.*

Clarence Holleman (Boeing), *Tension Joints*

Plexiglas—II

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In this test, a specimen 500 in. x 500 in. x 5 in. is placed in a jig consisting of two parallel, rounded, fixed supports 4 in. apart. A rounded pressure piece is brought to bear on the specimen at a point midway between the two supports. In this way, the specimen forms a simple beam, with the load applied at the center of the span. The maximum fiber stress can then be calculated from the formula:

$$S = \frac{3Pl}{2bd^2}$$

where P = applied load in pounds
l = span in thickness
b = width in inches
d = thickness in inches

The test jig is placed between the testing machine's cross heads, which move together at a specified rate

In this test, as in the tensile test, the flexural stress strain curve usually follows a straight line until it approaches the maximum stress. Next the curve turns upward until it passes the maximum, then it turns back. Here again the breaking point proved more variable (hence was a less reliable basis for comparison) than the maximum strength. Data—

Temperature: Variation of flexural strength with temperature, shown in Graph M14, follows a pattern similar to that for tensile strength (see Graph M7). At 50 deg. C., the material is soft and offers relatively little resistance to deformation. At 0 deg. C. and —65 deg. C., the material is so rigid that it fails before deforming appreciably. Point at which this failure occurs varies over a wide range of stresses, but both averages (shown in Graph M14) are relatively close to the maximum stress for the room temperature sample. This data, plus the results of our impact tests (see Graphs M1 and M2, Part I, January AVIATION) show how little the strength characteristics of Plexiglas are affected by low temperatures

Age and Pre-Conditioning: Effect of pre-conditioning on flexural strength differs from that observed for the tensile test in the fact that immersion apparently does not decrease the resistance to deformation As shown in Graph M15, however, pre-conditioned samples follow the same curve and reach the same maximum strength as the "as received" sample Notice that these tests were run at 40 deg. C

Rate of Straining: As in the tensile test, higher maximum flexural strengths can be obtained by using faster rates of strain, as shown in Graph M16. The usual rate of 0.05 in. per minute, however, gives more reproduceable results, therefore is used for the other tests in this section

Other Factors: At the same time that the effect of surface condition on impact strength was investigated, a similar study was made for flexural strength. Samples were prepared in exactly the same way and the same test program followed

Flexural strength results follow a similar, but not the identical pattern, as impact strength (as shown in Table III, Part I, January AVIATION). Samples with polished and planed surfaces and surfaces sanded parallel to the direction of stress all have approximately the same maximum flexural strength. Samples sanded so that scratches were at a 45-deg. angle, or perpendicular to the direction of stress, had definitely lower flexural strength. Again, these results refer only to the surface subjected to the greatest tensile stress in the test. Removal of perpendicular surface scratches by polishing or coating restored the flexural strength to normal. The effect of depth of surface scratching (as shown in Graph M8, Part I, January AVIATION) was also quite similar to the impact strength results.

B-25 Production Line

(*Continued from page 111*)

lowering them for joining to the center section on the final assembly line. After sections are thus removed, overhead carriers are run off the track end, and on to a track-high carrier on which they are taken to the head of the line where they are again attached to front and rear sections just lifted from the master jigs.

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Between the front and rear section lines, and flowing in the same direction, is the engine line. This, too, is of the overhead type. Power plants move through the numerous stations of this line as they acquire mounts, special equipment, wiring assemblies, and controls. From the final inspection station they roll across an aisle and are in position for attaching of the mounts to the nacelles facing them.

Center sections are assembled on a separate, mobile, powered line that starts from the tie-together jigs and merges with the rear section and engine lines in a combination turntable and elevator. Landing gear also is attached in this combination station and the fuselage is now virtually complete and has inner wing sections in place, as they were assembled as part of the center section.

Seperate Center Section Line

Center sections, composed of prefabricated side panels, engine nacelles, wing compartments, dividers, ribs, and sections of skin are tied together in a series of stationary jigs. As they emerge from the last of these they are attached to carriers of an overhead track system and begin their steady progress through 16 fabrication and 12 final assembly stations where structural riveting and installations are completed. The line moves at intervals, through power supplied by an overhead dragline.

Along this line apply and drill jigs and heavy tools are suspended and counterbalanced to save time, space and breakage. This practice, long in use, is proving of real advantage as more and more women take their places along the lines. Counterbalancing permits them to work with heavy apply and drill jigs that would otherwise prevent their employment for such jobs.

As the section enters the line a small rack or board is attached to the left side for the clipboards on which "Sign Off Sheets", "Mechanical Squawks", "Electrical Squawks" and "Shortage Sheets" are clipped. As the section proceeds down the line, workers and inspectors enter their reports on these sheets, the pads of "Squawks" remaining with the section until the plane, of which it will become a part, is completed and "sold" to the Air Force.

Joining Main Subassemblies

Fuel tanks, nacelles, wing sections and other major components of the center section are assembled in jigs in departments grouped about the head of the center section line. They feed their output toward tie-together jigs nearer to the starting point of the assembly line. Installations begin in the component assembly departments and continue throughout the 28 stations of the center section line.

About three-quarters of the way down the final line, the front section arrives, transported by the overhead carriers which suspend it on its final assembly line. Here, the front section is lowered to a cradle, casters of which run in tracks, which shuttles the front section into position for joining to the center section. When the two sections are joined, a carrier of the center section overhead line is attached to the front section, for additional support, and the shuttle-cradle is freed to return to pick up another front section and shuttle it into position for joining to the next center section on the line.

Overhead Turntable

An ingenious floor-saver stands astride the end of the center section line. It is a combination turn table and elevator which is also a working station. The now combined front and center sections leaves the powered portion of the center section line and are rolled forward by hand on to the overhead rails of the turntable elevator. There they are turned 90 degrees, with nacelles facing the end of the engine line. The engines, which flow off of the end of a previously mentioned installation line directly into the turn-table elevator, are installed and the assembly is rotated 180 degrees in the turn-table elevator, is elevated so a floor carrier of the final assembly line can be run under and be attached. A fuselage rear section then rolls forward and is joined.

When ready to leave the turn-table-elevator station, landing gear will have been attached and the overhead carriers removed. Mounted on the floor carrier the now completely joined fuselage-inner wing assembly rolls nose forward in a 90 degree arc and starts down the first of four legs of the final assembly line.

Drag Line Conveyer in Final Assembly Lines

Before the remaining joining, installation, and painting operations are completed, the ship reverses its direction three times, traveling the length of the final assembly line four times, to emerge from the master paint booth onto the final check ramp where it receives pre-flight tests and tune-up.

Carriers used on the final assembly line are triangular-shaped platforms mounted on two grooved, small wheels at the base or wide end, and on two plain casters at the apex end. At those portions of the line where lateral direction is required, the grooved wheels run in U shaped steel channels or on flat steel "rails". On the straight-away portions of the line they run on inverted

V-shaped channel iron rails which fit the V-shaped grooves in the wheels. The apex wheels run on the floor when the carrier direction is straight and between flat steel bands or in U-shaped steel channels when it is necessary to guide them.

Power for either interval or continuous movement is applied to the line through draglines which slide along just above the floor, centered between the rails. They are inverted U-shaped channel steel, and fit over smaller, similar channels anchored to the floor as guides. Power is transmitted to the channel dragline by a standard chain dragline under the first two stations of each leg of the four-leg line.

For forward movement, dogs on the channel dragline engage pawls on the steel frames of the carriers, pushing the carriers forward continuously or intermittently, as desired, the length of one working station. Then the channels are pulled back until the dogs pass under the pawls of the next carriers and are in position to re-engage them. At that point the dragline stops and reverses its direction, pushing the line of carriers forward again.

The twin-tail empennage is assembled from pre-fabricated sections, on a line housed in a balcony above a stockroom section of the main floor. Complete tail assemblies are transported by traveling overhead cranes from the balcony storage space to a position directly over the first station of the final assembly line. There the empennage is lowered and bolted into place. Jigs in which tails are assembled are of an unusually flexible design that permit their being turned easily from vertical to horizontal positions as the work requires.

Outer wings are assembled in stationary jigs, in two major components, the leading edge and the trailing edge. When firmly tied together these components are removed to castered jigs, running on the floor with casters guided by parallel strips of steel band attached to the concrete. Leading edge sections pass through 14 stations and trailing edge sections through 6 stations, to reach the master wing jig. Here the two components are tied together and are about 70 percent completed before being removed and attached to carriers of another overhead line. On this line, which moves continuously and doubles back to its starting point, outer wing panels, rights and lefts alternating, are completed.

A feature of this overhead line that reduces worker fatigue and expedites production, is varying track levels. Between several of the 27 stations on this line the track rises or drops to raise or lower the sections to the most convenient working height.

Another feature, designed to eliminate confusion, is suspension of electric power and compressed air lines between the two rails of the overhead track, on reels with spring rewind. Spaced so each station has whatever number of lines it needs, with just enough unwound to reach the work, this feature keeps the floor from becoming cluttered and lines out of the way of workers.

Upon completion, the outer wing sections are transported in cradles to the last station of the second leg of the final assembly line, where they are attached sufficiently for the swing-around of the ship into the third leg. On this third leg joining is completed and all connections of tubing, wiring, and cables are made.

Flexibility in equipment for doing the work along the four legs of the final assembly line is well illustrated by the stands and platforms which surround each ship. These are of tubular steel framework with wood floors, mounted on swivel or fixed direction casters which are guided by channel iron tracks. Main platforms are built for a particular working point and are joined to the plane carrier by eyebolts and pins. Other stands are added as the work requires, and attach to the carriers or to the main platforms. They are attached and detached in a few seconds, but while in place roll with the ship.

Throughout the plant, whether in fabrication or assembly departments, arrangements, machines, tooling, material flow—in fact everything—is as flexible as it is humanly possible to make it. Just as war requirements prevent rigid freezing of designs, so also do they forbid rigidity in manufacturing methods.

To adhere to the flexibility rule it is necessary, among other things, to keep a rather large plant-maintenance department busy moving equipment, assembly lines, stock rooms, and the hundreds of other essentials of a big manufacturing plant. Since this article was first requested by AVIATION, for example, preparation of it has been postponed twice because of major changes in the B-25 lines. Each change brought still greater efficiency, or made possible changes in the planes themselves that increased their effectiveness.

Rubber Hose

(*Continued from page* 158)

by the same things that attack all rubber goods. Oils, acids, alkalis, solvents, greases, gases, thinners, and

(*Turn to page* 366)

* * * * *YOU* * * * *

were at Casablanca

THE interesting thing about this Casablanca business is the terrific wallop our country is packing in international affairs these days.

We've been on the muscle just a little more than a year, now, but the boys who came up through the prelims are already calling us "Champ" . . . and it looks as though the other corner of the ring is beginning to dread the finals.

▶ How come? It wasn't so long ago that Brenner Pass and Berlin meetings were dominating the world's headlines.

YOU made the difference. "You" meaning every American who worked hard last year in America's war industries. Because a statesman, or a general, can only be as good as the industrial strength he represents.

▶ By the very act of shunting America's mighty industries from making peacetime things like automobiles and streamlined trains to making wartime things like ships, bombers and guns, the voices of your representatives were magnified from whispers to thunder in the councils of war.

YOU were at Casablanca (*Cont'd*)

If that makes you feel pretty proud, as a part of the industrial system that is going to burn the bearings of the Axis, maybe you'd better think about what is going to happen to our industry (and, incidentally, to your job) after the war is over.

▶ Things could get in a terrible mess, you know. We'll have the biggest debt in the history of the world, and 10 million soldiers and sailors to find jobs for.

The only thing that will save us will be the last thing most folks will think of—making it easy for business to grow.

If business grows, jobs grow.

Good business is the source of all good living.

America invented the method that produces better living. Here it is:

1. Constantly improve the equipment available for the worker.
2. Use the lowered costs thus produced to
   (a) Lower prices to consumers.
   (b) Improve the standard of living.
   (c) Provide incentives for invention, leadership and investment.
   (d) Lay aside "Seed Money" that can be used to start over again at item 1.

That's all there is to it. That's what gave us the highest living standard on earth. It can take up the job after the war, taking care of you, the soldiers, the sailors, and the war debt—IF it is allowed to operate.

But there are hundreds of laws that gum the works. Both business and labor need laws, the same as any other humans, but they need laws that will *lubricate* the industrial machine.

Let's take two of the gummy ones: There's a law that says a business must take 20 years to charge off a machine. Look what that does to item 2 in our "recipe for good living." Most machines are obsolete in 5 years, and government should encourage scrapping them. Obsolete machines *prevent* lower costs and *keep* wages down.

Another law, the excess profit tax, confuses business profit ("Seed Money") with private profit. In preventing a crop of war millionaires, this law also takes away most of the "Seed Money" that business should be saving for the big expense of converting back to peacetime work.

That law ought to be changed. If you think so, too, ask your congressman to study all laws with this principle in mind:

"What's Good for Business is Good for Americans"

THE McGRAW-HILL NETWORK
OF INDUSTRIAL COMMUNICATION

22 publications, which gather "war-news" from the "war-production-front" through a staff of 153 editors and 725 engineer-correspondents. More than 1,500,000 executives, designers, production men and distributors use the editorial and advertising pages of these magazines to exchange ideas on war-production problems.

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practically all chemicals harm rubber. Keep the hose clean. If it should come in contact with a substance that will harm it, wash it off. Rubber goods are weakened by water if the immersion is for a long period of time, but otherwise it is satisfactory. Soap can be used.

Practice of wire winding hose has been eliminated for the duration. Generally speaking, the disadvantages outweigh its advantages. It should be resorted to only in exceptional instances even when the wire is available.

Shut-off valves should always be located ahead of the hose, so that the air, water, paint, or whatever is being conveyed, can be cut off when not in use. Hose is designed as a means of conveying air and fluid and not as a storage place. Placing a shut-off valve at the end of the hose, rather than at the point through which the fluid enters the hose, makes for greater wear on the hose when not in use than when it is used. This is due to building up of pressure. The amount of service that may be expected from it is accordingly reduced. Hose also has a recovery period when not in use. In other words, hose has a tendency to give much longer service when used intermittently than if used continuously. This is particularly true when the usage is rough.

Another commonly followed harmful practice is that of shutting off the hose flow by kinking it or bending it at a sharp angle. This sets up a physical stretch strain on the rubber as well as the building up of excessive pressure by the fluid within the hose.

Storage

When not in use, hose should be carefully coiled (without kinks) and laid out on a flat surface. Where a fluid was being conveyed, it should be flushed. If hose is to be hung up, it should not be put on a nail or any similar object. This puts the strain on one part of the hose for its whole weight and length. If nails or pegs must be used—by using several of them, this ill effect can be avoided. It is good policy to use hose racks provided for this purpose (see Fig. 7).

A hose reel is an excellent investment where hose must be moved from place to place and its weight is such that this movement is difficult. Dragging a hose wears the cover unduly since covers are not designed to absorb this type of punishment. The probability of cutting and pitting is ever present, plus the possibility of the hose being brought into contact with oil, grease, or other substance that may shorten its life.

Air hose is by far the greatest single hose item used in an aircraft plant, and it is used primarily as a source of power for rivet guns. There is a great variety of air hose on the market, hence much care must be exercized in selection. There is a tendency among some aircraft manufacturers to buy an expensive heavy hose to assure themselves against failures and the maintenance expense involved in repairing them. But investigation has shown this theory to be all wrong. A heavy hose puts an added burden on the man with an air tool since he must support part of its weight also and hence the loss of efficiency runs high. *Use the lightest possible hose that will carry the air power necessary to drive the tools.*

Each decrease in hose weight will reduce fatigue. Nor is it necessary to use a hose with a large inside diameter. One-quarter inch inside diameter will provide enough air to run any aircraft rivet gun. Very likely, a great deal of the swing to heavier air hoses, say ⅜-in. and ½ in. sizes, would not be necessary if the compressors were operating efficiently or perhaps if sufficient compressor capacity was provided. Furthermore, the weight increase with an increase of inside diameter is tremendous. . . Standard 5-ply ¼-in. hose weighs 13 lb. per hundred feet, ⅜-in weighs 16 lb., and ½-in weighs 30 lb.

It is extremely seldom that an air hose really wears out. Failure occurs at the coupling or from oil saturation in the hose in about 98 percent of all cases where some provision to eliminate these conditions is not made.

Oil Damage

Let's get at the oil condition first. While there are so-called traps, there is hardly an air line where oil from the compressor cannot get in. Right then the trouble starts. The action of oil on rubber is well known. It swells and deteriorates it. That's just what happens inside the air hose. The tube absorbs oil and swells. As it swells, the inside diameter of the hose is reduced and the gun does not get enough air. This slows down production. Pieces of the disintegrating tube slough off and are blown into the gun. This may cause maintenance expense.

But all this time the hose, from the outside, looks like a fresh, healthy piece of hose. Where the oil condition is bad, the hose will begin to swell within one week after being put into service. Eventually the cover shows signs of wear and begins to peel off or be worn down very quickly by abrasion. What has actually happened is that the oil has soaked through the tube and carcass of the hose to the cover. It causes ply separation or the separation of the cover from the hose, or so deteriorates the cover that it wears down quite easily in natural service. An inexpert person could

never tell what the actual cause of the hose failure was. It really looks as if it has worn out. Actually, its term of service might have only begun.

There is one simple easy answer. Order an air hose that has a tube that will not be affected by oil. Merely being oil resistant does help some but not enough. True, this type of hose will cost from 10 to 20 percent more than the same hose without the necessary synthetic tube, but it will more than pay for itself in the elimination of the above difficulties. The WPB is currently considering requiring that air hose be furnished with synthetic rubber as a step in the rubber conservation program.

Failures at Couplings

It is not difficult to understand why hose failures tend to occur at the couplings. The use of hose puts much more strain upon hose at the point where it is attached to rigid fixtures than anywhere else. A re-usable coupling should be used. This should be of a standard type on which air-tight connections can be made in the plant. When installing hose, use a length about two feet longer than necessary. When the hose wears at the coupling, the end can be cut off and the coupling reset with the loss of only about 2-in. of the hose in each operation.

Welding Hose

Welding hose is really air hose and except that the oil condition does not arise, all considerations are the same. There is no need for an oil resisting tube in a welding hose. For the sake of standardization, a hose of the same inside and outside diameters as the air hose should nevertheless be used, except that a tube unaffected by oil must be specified for the air lines.

Aircraft plants have fire hose, and although it is hardly ever called into service, care must be taken of it so that should the occasion arise it can be used. This hose is generally left on a rack and the choice of location has a great effect on the life of the hose. The same considerations reckoned with when hose is stored must be taken into account. In addition, fabric hose will mildew if left in a damp place.

Linen and cotton rubber-lined fire hose have a tendency to absorb fumes that will destroy them. Cotton, rubber-lined fire hose should be put into use every few months and the location of the folds changed when being re-racked. This will help prevent creasing and drying out.

Paint Hose

Always clean the paint out of a paint hose immediately after its use. Use dilute solvents of a type that will not destroy the hose tube. Paint-hose tubes are made of synthetic rubber. Your supplier can tell you what cleaners to use. They vary according to the material in the tube. This should be followed by sending air through the tube with sufficient force to blow out the cleaner since the cleaners are also harmful if left in the hose.

Many a paint job has been spoiled by a sloughing off of color from the hose tube into the paint left in it. When painting is resumed, it blows right out onto the surface being finished, in addition to the harm done to the hose.

There are certain solvents used in cleaning and painting for which rubber-lined hose cannot be satisfactorily used.

Water Hose

Where there is a possibility of freezing, always be certain to remove the water from the hose. Many plants use hot water for wash-up purposes. Hot water has a tendency to swell rubber. As it swells the tube of the hose, the inside diameter is accordingly reduced and a smaller flow results. As the rubber swells, its porosity increases and very often the carcass of the hose is attacked. In addition, a warm hose is infinitely more susceptible to destruction by oils, greases, and chemicals than a cold hose. It is a good policy to drain the hot water from the hose as soon as possible after using.

Sand Blast Hose

Until the rubber emergency, sand blast hose tubes were made of a very high grade pure gum compound that stood up remarkably well considering the service it was put to. As one of the means of stretching our rubber stockpile, the WPB has restricted the amount of crude that can be used in the tube. The resulting product has not been giving very satisfactory results and a question exists as to whether or not a savings of rubber has been effected. The short service the hose with a reduced rubber content has been giving makes for the use of more hose and possibly an even greater consumption of rubber.

Now more than ever, it is important to take the best possible care of sand-blast hose. There are two things that must be done. First, have as few turns or bends in the hose as possible. Sand-blast hose invariably wears out where it bends, never where it is straight. Second, rotate the hose; that is, shift it from job to job and reverse its ends as often as possible to keep it from wearing out at the bending point. Try to distribute the burden of "taking the bend" over as great a portion of the hose as is possible. Rather than trust your memory, develop a method of recording what part of the tube is worn.

Paint marking outside of the hose can help

The attack of sand-blast hose by static electricity is no longer a problem. By means of a conductive hose, generally made by running a small static wire its entire length, manufacturers produce a hose that will give no trouble from this score

Conclusions

Do not throw away worn pieces of hose. When a break occurs in the middle of an otherwise good hose, cutting out the bad spot and putting in a coupling will allow the hose to live its normal life. Since couplings are reusable, the only expense is for the labor involved. This same procedure may be resorted to when a piece of hose is growing short because the couplings have been reset several times and the few inches removed each time has made the hose too short for the intended purpose. A small piece of hose attached to either end will permit additional service.

Hose should not be discarded unless one is absolutely certain that it can be of no further service. If part of a hose is good, cut it out and save it. These pieces come in handy for coupling purposes.

If hose is standardized in a plant so that a minimum number of sizes or types are used, utilization of small pieces becomes rather simple. Where many different types of hose are used in a plant, additional couplings as well as hose stock must be maintained. In proportion the number of unnecessary types used, there is less opportunity to use salvaged pieces and the difficulty of a sensible program is increased.

When you are really done with hose, the rubber content makes it worthwhile in the rubber scrap drive. See that it gets in.

Improved Life Rafts

(*Continued from page* 261)

lower chambers so that piercing of the bottom will not sink the raft.

As the raft is inflated, the carrying case becomes a sea anchor to keep it from floating away and which, if necessary, may be used to keep the nose of the raft into the wind to reduce possibility of capsizing in heavy seas.

Equipment includes bailing bucket and plastic hand pump, both tied by individual cords to the raft, a square sail which can be rigged on the wooden oars, and a tarpaulin to protect the crew from rain or sun. Additional "accessories" include fishing kit, emergency repair and signal kits, first aid equipment, concentrated rations for 30 days and, in some cases, radio sending set. These items, supplied by the Air Forces, are secured in a water-proof container to prevent their being lost when the raft is being launched or in case it is overturned.

In the field of one man rafts for carrier based fighter pilots, engineers of Walter Kidde & Co., have developed an automatically ejected and inflated raft. The new design uses a water sensitive switch on the underside of the plane's fuselage which automatically opens release valves on two carbon dioxide cylinders. Gas from one cylinder open the raft compartment in the top of the fuselage while the other inflates the raft, which is prevented from drifting away by a light line. The cylinder which opens the compartment stays with the plane, while the other is attached to the raft.

In addition to the automatic water-operated release, manually operated controls are provided for both cylinders.

Fire Protection Equipment

(*Continued from page* 241)

reaches the scene of potential fire. Other engineers stand by each nacelle (Fig. 3) to check on the gas discharge, which also serves to remove any dirt accumulations from the piping and shows up possible leaks.

This piping leads almost directly from the carbon dioxide cylinder to the four engines, but passes through the control panel where the flight engineer can set his valves to discharge the gas into any one burning engine. A double carbon dioxide container is also provided to give a burning engine a second shot of gas in the event that the first one does not completely extinguish the flames.

In addition to this unique built-in fire extinguishing system, each *Clipper* also carries (Fig. 4) portable carbon dioxide guns in each engine nacelle. These portable units, which have pistol grips and triggers, each contain two pounds of liquid carbon dioxide and are used like a tommy gun for fighting localized fires within the wing cavity or engine compartments, all of which are accessible to the crew during flight.

Additional guns of this type mounted conveniently in the passenger cabins and crew's compartment provide for instantaneous control of accidental fires.

America ot War

(*Continued from page* 91)

aircraft. The President keeps telling Hitler that we will hit him hard somewhere in Europe. Of course, it's a good idea to tell him that, regardless of the plans of Allied staffs.

If the general staff had in mind an all-air thrust at Europe, the problems involved would be tremendous. Until

you take pencil in hand and start adding up, with the help of a military aviation authority, what it takes to run an air show, you may be inclined to think of aviation as a royal shortcut to avoid the grind of battle on the ground. Just recall that months ago the British mustered a few thousand-plane raids on Europe. At that time they talked about three-thousand-plane assaults. Since then the United States has established a second air force in England, but still there are no attacks anywhere near that scale.

It takes great supplies of men, oil, spares, food, airfields, and warehouses to sustain an air campaign. The casual observer wading through the figures is likely to feel he is having one of those nightmares in which he tries to run and can't. Fuel, for example, is a particularly hard problem. Combat air engines burn more than 50 gal. apiece per hr., and planes probably average about two engines each. It is more than likely—and this is only informed guessing—that fuel is one of the worst of bad gremlins we have to deal with in the African project.

Not one of our aviation theatres—and we have a dozen or so—is nearer than 2,000 mi. from home base, some of them are 6,000 or 7,000. Hitler, by contrast, is in no case operating *more* than 1,500 mi. from factory to front. He is only a couple of hours from his British targets but, per contra, the British are only a couple of hours from some of theirs. Yet, after four years of war, and after the production of perhaps 200,000 planes to fight this war, we still read about 10, 50, 300, or so, taking part in an action.

Hitler had ten years to prepare the plant to build any number of airplanes necessary to overcome all opposition, but he made several serious miscalculations—the worst being that he would strike one stunning blow with the designs current at that time. Now, considering the huge task of designing and developing new models to meet those of his enemies, his Luftwaffe is in a weak that many observers cannot help but express their surprise.

There must be a combination of reasons for this condition, but even War Secretary Stimson appears not to know what it is. He says that we may have overestimated Germany's capacity for producing airplanes in the first place; that Germany may be suffering a severe shortage of aviation gasoline; or that she may be gathering her air power for an offensive of which we are not yet aware. If we do not think any of these explanations is very convincing, we may assume that the secretary has a better one which he is keeping to himself.

But the difficulties that beset the building of air forces are not enough to stall the great industrial and manpower of the United States. Our production is past 6,000 per month, and of all the vast factories and millions of workers and mountains of metal and supplies going into the war production machine, more than 40 percent is now devoted to aircraft.

Nevertheless, our troubles are many. We have irresponsible absentee workers by the thousands every day; our engine production gets ahead of plane output; we still cannot deliver forgings and castings fast enough; "change orders" come from the front so fast that often only 10 or 20 planes are made alike; we set up modification centers to keep from stopping the production line, and the centers horn up the manhours; then we have to drop a model entirely and start on another one. That will happen several times in 1943. Not the least of problems is the oracle at Washington from which all programs flow. Some of the best managers from industry—not bureaucrats—are there, but the demands on them are almost too much for human wit at its best.

The very mountainous proportions of the aircraft program in the war are becoming more and more of liability for peace, and some bosses can't resist taking an eye from the immediate goal for an occasional glance into the future. It is rather appalling to think that nearly half the industrial power of the United States has been converted to aviation, that before the war ends it may be more than half. It's going to be a morning after the night before when the show is over and a great deal of this plant capacity has to get back to egg beaters, wheelbarrows, dollar watches, or what have you.

Nothing much is being done about that, as they say, except that the boss must lean back and give it a couple of thinks now and then. As we have reported before, the aircraft people are aware that they are qualified, by new techniques and familiarity with new materials, to make a large number of old things in very new and interesting ways. And when the time comes they will—they will have to.

Operation of airplanes, come peace, is of immediate national and international interest, and steps have already been taken to meet swift turns of events. Complicated events, too. It so happens, that because the United States is on the other side of the world from the war, and because we are manufacturers, our chief role has been the Arsenal of Democracy. In that capacity, we needed a lot of airlines to girdle the world. We established them forthwith. Meanwhile, England, Holland, Italy, France, and Germany have neither the time for airlines nor the airplanes to equip them. So the war will end with the American flag on airways all over the world.

This situation, like Topsy, "just growed," and since the war started there has been little, if any, time to consider its implications. For another thing, even though Pan American Airways began foreign operations about 17 years ago, the country still lacks a foreign aviation policy. For several years before the war, the government indulged in small-time horse trades with England, France, Germany, Italy, and Holland, on who could run an airline where. Before bigger things showed up, there were times when conniving over a Toonerville line to some Pacific atol was good for a three-day run in Washington's bars.

At any rate, we had no policy when the war started and, as of now, all deals are off. We have the airlines. This situation began to disturb the British a few weeks back, so that certain MP's felt obliged to warn Britain against our monopoly, and even went so far as to recommend boycott of our lines. Washington was caught flat footed, with no plans and no basis from which to make a reply.

The President quickly appointed an interdepartmental committee to study the matter and make recommendations. Its deliberations thus far have been strictly secret. This committee has matters on its mind for heavier than Britain's fears, although the administration certainly does not want any quarrel with England about airlines. The committee has to decide what the United States will stand for when it goes to the peace table.

For centuries, the nations have held that the seas are free to all. No country attaches any claim to the ocean. But the air is different—it goes right over the land, all of which belongs to somebody. Shall the aircraft of the various nations be allowed to take any route they wish, over other countries, or do all countries have sovereign rights in their overlying air, not to be intruded upon? This is the biggest question that has come before aviation since the barnstormers started work without law, license, or rules. We certainly wouldn't expect the Mexicans, for instance, to allow us to run a railroad across their country. Is an airline entirely different?

When the President's committee decides this question, the final answer will still be a long way off, because we can only recommend to the international air commission (or whatever name) which will be part of the final peace machinery. The Russians and the Argentines and the Portuguese and the Greeks will all have their ideas, too.

Whether we have freedom of sovereignty of the air, we shall have to decide whether we have freedom of entry. That is, can anybody start an airline to any port in the world. You can practically do that with steamships—if you want to. Would the low-wage countries drive us out of the air, as they drove our merchant ships off the seas?

It is a safe guess that our government does not intend to try to harness the planet's air operations, just because the war threw them into our lap. We couldn't follow up such a policy even if we wanted to. But, since the future of the United States in world air commerce is being made now, we ought to watch all the plays.

Building Winning Spirit

(*Continued from page* 101)

had flown to Pearl Harbor for first-hand conferences with Navy pilots who had fought at Midway, he called small groups of the men into his office to discuss with them what he had seen and heard.

Out of the first trip grew the company's five dispersal plants, now scattered over the area. The British had instituted dispersal plants in order to put their eggs in more baskets. Jake recommended the same system to Grumman because he recognized other advantages as well. By acquiring unused factories in which to manufacture small parts, the company has saved money and materials which would otherwise have gone into building new plants and, at the same time, has helped to relieve the transportation problem by bringing the work nearer to people's homes.

Stability of the employees can be explained largely by the fact that over 95 percent of them are native to the region, as are Pres. Roy Grumman, Chief Engineer William Schwendler, and Gen. Mgr. Jake. Many of them own their own homes and grow their own vegetables. The pride which they take in their possessions they also take in their work and in their company. In fact this unbounded pride has led to a healthy rivalry between them and neighboring aircraft plant workers. Achievement is the theme.

When the wing department in the *Avenger* plant formed a 400 Club, they did it with the avowed purpose of turning out 400 wings a month.

In spite of a 2,300 percent increase in production during the past two years and the blow of losing skilled men to the Armed Forces, Grumman has con-

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tinued its policy of drawing its employees almost entirely from nearby towns. One way in which the personnel department has done this is to encourage the men and women to tell their friends about the jobs open to them at the company. Whenever a man leaves to join the Army or Navy, the personnel department asks him if he has a father or brother, sister or mother, wife or girl friend, who might be interested in working for Grumman.

"If a man has been a good worker," claims Jake Swirbul, "it's a pretty safe bet his relatives will be, too." And this policy helps not only the company but also the army. When a draftee knows the organization is taking care of his relatives, he is relieved of financial worries and makes a better soldier.

Another way in which the company finds good workers is through the schools. Grumman is in close touch with all the principals and many of the teachers, and a number of schools give courses in cooperation with the engineering department. At the plant's request they all recommend boys and girls from their graduating classes whom they think the company would like to interview.

The plant also has eight schools of its own in which to train new employees. This program was started in June 1940 and has grown continually until there are now over 1,000 people in the schools. To be eligible for the training, for which the pupils are paid, a prospective employee must be a resident of the local counties. Therefore, they all have a sense of homogeneity from the start. Moreover, their teachers are all loyal employees who imbue them with a spirit of loyalty to the company even before they start work in the plants.

An increasing number of these trainees are women, for the company is counting heavily on its womanpower to get its planes flying. An extreme case is the electrical assembly plant where all of 100 workers are women. "Now it's the women who whistle when a man comes into the shop," says Jake Swirbul with a laugh.

In order to provide for the young children of women workers, nursery schools have been started at the various plants. Mothers can leave their children at the schools when they come to work in the morning with the assurance that the children will receive excellent care from trained nursery school teachers hired by the company. This is typical of the kind of interest and foresight on the part of the management which have helped to make the employees unanimous in their desire to build the best, and the greatest number, of Navy planes.

One remarkable feature is Jake's office door—it is always open. Every man and woman in the company is free to go in to see Jake at any time and tell him his problems. When someone comes in, Jake finds out his first name, and calls him by it—Tony, for instance—and he expects Tony to call him Jake. Immediately Tony feels at ease. Because Jake always explains how he comes to the conclusions he reaches and because he is inherently fair. Tony leaves the room satisfied that Jake's judgment, whatever it may be, is right.

Actually very few people go in to talk with Jake, but those who do often check a feeling of discontent, caused perhaps by some minor friction, before it has had a chance to grow. The others know that their vice-president will always lend them a sympathetic ear, and that is enough.

Athletics have undoubtedly played a large part in building company morale. However, the athletic program originated with the men. There has never been any athletic director to organize the teams. In true democratic fashion the men have organized themselves. They wanted to have intramural bowling teams, so they obtained permission and started matches. So great was the enthusiasm that the company quickly cooperated by installing six bowling alleys in one of the plants. Today bowling is so popular that the teams regularly lure outside alleys for their matches.

Basketball, baseball, softball, and other sports soon followed. From early spring until late fall, the baseball diamonds are humming with activity every noontime. Usually a softball game will take two days, starting during lunch hour one day and ending during lunch hour the next. All in all, about 5,000 men and women participate in some kind of sport.

The Athletic Council, comprised entirely of men from the plants, has divided the employees into an intricate network of leagues and teams and one day every year sponsors a Field Day at a nearby municipal stadium. In addition, they arrange outside games for "all-Grumman" teams and issue season tickets to the 10,000 members of the Athletic Association for all home games. A special drawing card is the basketball team, which holds the national professional championship.

Grumman's winning teams have attracted some of the area's best athletes, much as the Navy's pre-flight training school football teams have attracted football players from all over the country. Obviously these athletes make good workers because they coordinate well and carry over the winning spirit to their work.

Because of their enthusiasm, the men and women are continually making new production records. Last April the Navy recognized their outstanding achievements, both quantitatively and qualitatively, by conferring upon Grumman the first Navy "E" for airplane production. Again in October the Navy gave the company the first star for six months of continued excellence.

Another popular "extra curricular" activity is band playing. This, too, has arisen entirely from the men themselves. One of the best swing bands in the country, composed of many men who used to play for famous name bands, is right at the plant. For special occasions, such as the "E" ceremony, the company's two military bands, boasting 120 pieces, provide the music. Not to be outdone by the men, the women are now starting a band of their own.

Last fall some of the men got together with Personnel Director Paul Gilbert to design a special company calendar and sell it to the employees at cost. With excellent colored illustrations, it made a fine Christmas present. In the front of the calendar are pictures of Roy Grumman and Jake Swirbul—in shirt sleeves as usual—and on each page are more pictures, showing the growth of the company and the various planes which it has produced.

One of these pictures shows Grumman's five current types in formation flight. Important company dates are printed in red with a few words explaining their significance. At the back is a brief history of the organization since its founding in 1930.

No small factor in maintaining morale is the *Grumman Plane News*. Published "by and for the employees" every Thursday, the paper contains items of personal interest, sports news, production news and, most important, the latest reports on the performances of company planes. Through *Plane News* all the employees know that their *Martlets*, which comprise almost the whole complement of every British carrier, enabled the Malta convoy to get through. They know their "*Wildcats*" have been driving Jap planes from the skies over the Solomons at a rate reaching 10 to 1 in October. They know their *Avengers*, under an umbrella of *Wildcats*, saved Guadalcanal from Jap invasion in November by sinking a battleship, two cruisers, and twelve transports. And each week they read accounts of new Allied successes in Grumman planes. No wonder they have set their minds on making more and more planes faster and faster!

The men and women know that the planes they are making are the best of their kind in the world. In the past, these top morale workers have become champions of production for the Navy and they are determined to keep this championship.

Doctrine of Air Power

(*Continued from page* 99)

siderations and types, is in order:

(1) General Arnold stated a year ago that the single-seat fighter had proved its superiority in the war to date, and that view appears to stand. This type has the greatest speed, fastest climb, and highest degree of maneuverability —all prime considerations in a fighter plane.

(2) Several specialized types are required, including medium altitude Army cooperation fighters such as the Bell P-39 and Curtiss P-40, fast climbing interceptors such as the Lockheed P-38 *Lightning* and forthcoming North American P-51 *Mustang II*, high altitude sluggers like the powerful Republic P-47 *Thunderbolt*, also specially adapted night fighters such as the new Douglas *Havoc*, similar to that used by night fighter pilots of the RAF.

(3) Our heavily armed *Fortress* and *Liberator* bombers, and their larger and more powerful successors, will undoubtedly prove their ability to carry out their distinctive daylight precision raids largely without fighter escort. Raid after raid over Europe has shown that of the enemy planes destroyed more than 90 percent have been knocked out by the bombers. As in the battle of Britain, when the *Hurricanes* and *Spitfires* ignored the escorting Messerschmitts and Heinkels and went after the lightly armed Nazi bombers, the FW-190's and Me 109G's still are refusing to tangle with the convoying *Spitfires* and *Lightnings* which fly ahead and/or above the bombers, and have tried to get the *Fortresses* and *Liberators* themselves.

However, up to the present, the American 50-cal. guns, effective at 800 to 1,000 yd., with power turrets, semi-automatic gunsights, etc., have been taking a terrific toll of Nazi fighters, and another point in American air doctrine has been justified. That eventually the enemy will have some sort of an answer we can be sure, but we may be able to keep at least a jump or two ahead with our own developments.

Among those prominent in the development of American fighter aviation are Maj. Gen. Carl Spaatz, air chief under General Eisenhower, and Brig. Gen. Ennis Whitehead, in charge of the Fighter Command in Lt. Gen. George Kenney's hard hitting air force under General MacArthur, concerning which Capt. Eddie Rickenbacker paid such a glowing tribute on his return to this country after the miraculous escape of his party in the South Pacific.

And don't overlook Brig. Gen. Claire Chennault, wizard extraordinary, directing genius of the Flying Tigers and now chief of the China Air Task Force. Although not linked directly with the original GHQ Air Force group, Gen. Chennault ranks as one of the world's leading exponents of air fighter tactics and holds an important place in the development of American air doctrines. His eleven principles (as worked out in his well nigh unobtainable book on the subject) received a vindication in the amazing record of the American Volunteer Group, and by express invitation of Gen. Arnold they are being incorporated in the instruction given fighter pilots at our advanced single-engine training schools and in operational training at fighter bases.

Another prominent air officer, Maj. Gen. Jimmy Doolittle, commanding the 12th Air Force in North Africa and hero of the first Tokyo raid (General Arnold has promised some more!) should be brought into this total picture, although not connected with the immediate GHQ Air Force group. Jimmy Doolittle has had a tremendous influence in the technical development of military aviation in America as well as in our strategic conceptions of what air power can do. He appended a courageous one man minority statement to the Baker Board report of 1934, opposing the majority opinion that Army aviation ha left *status quo*.

Air Supply

Exploits of fast-flying fighter planes —dogfights at 40,000 ft. and breath-taking dives at 700 mph,—the feats of giant long-range bombers hold top public attention because collectively they offer the glamour of air power. But equally important is the primary, though more prosaic, supporting function of air service, the ways and means to "keep 'em flying." It is highly essential that rivets and spark plugs, engines and props, wing sections and rudders, wheels and tires, machine guns and ammunition, bombs and bombsights, radios and instruments, are available instantly for tactical units when needed.

For there is nothing so helpless as a grounded airplane. A rapid survey—say, in a B-24—of the fighting fronts in 1941 and to a large extent in 1942 as well, would have revealed hundreds of fighters and bombers on the sidelines itching to get back into the scrap but useless for want of spare parts and servicing facilities. This is one of the main reasons why American air power could not exert its influence more fully until the late summer of 1942. It took time to get this service worked out for combat areas five to ten thousand miles away. But today that B-24, by way of example, has become the C-87 *Liberator Express* and the story is different.

The importance of rendering air power largely self-sufficient by means of an transport was clearly seen a dozen years ago, and it is another fundamental of the American doctrine of air power. No doubt the great distances between our few and scattered air units had a great deal to do with this. Necessity is the mother of invention, and to prove that the impossible could be done, Col. Knerr, commander of the 2nd Bombardment Group at Langley Field in 1930, carried out maneuvers in an isolated part of the country, saying to his officers and men: "We don't fly or we don't eat unless our supplies can be brought in to us by airplane." They flew and they ate.

Transport Service

When the War Department organized the GHQ Air Force in 1935, the transport squadrons became a separate part of the Air Corps. The 1st Transport Squadron was organized at Patterson Field, and others were formed at the air depots located in Pennsylvania, California, and Texas. Bellanca C-27's were used at first, and then Douglas C-33's (converted DC 2's). Later, to relieve the Material Command in Ohio, which was badly overworked with defense contracts for aircraft and equipment, also engineering and experimental

development, a Maintenance Command was set up at Patterson Field. This has now become the Air Service Command, under Maj Gen Walter H Frank, with a Domestic and an Overseas Division

It is this outfit which has the responsibility of filling maintenance and supply needs of all Air Force units throughout the world, in cooperation with the Base Service Command organized as an integral part of each Air Force To keep all this service going, hundreds of 2-engined Douglas C-47's and 53's, Curtiss C-46 *Commandos*, 4-engined Douglas C 54 *Skymasters*, and Consolidated C-87's are daily winging their way over six continents and the seven seas.

Airlines to Everywhere

The pioneering and operation of four great air routes and the actual flying of airplanes, equipment and supplies, key personnel, and mail is the function of Maj Gen Harold Lee George's Air Transport Command The vast operations of this amazing outfit constitute one of America's most remarkable "rabbits out of the hat" yet revealed in the war.

First titled The Air Corps Ferrying Command, it was created in May 1941 to deliver into British hands the combat planes allotted to the United Kingdom under the lend lease program. Col (now Maj Gen) Robert Olds was in charge, and under his dynamic leadership, the organization grew rapidly, extending its special delivery service to the various democracies fighting the Axis, as well as to the tactical units of our own Air Forces, wherever found

Within a few weeks an Atlantic route (1) was opened up, shortly to be followed by the survey of a South Atlantic-African route (2) laid out in cooperation with Pan American It is safe to say that the task of clearing the Afrika Korps out of Egypt and Libya was greatly aided by this remarkable trans-African airway The South Pacific life line by air (3) has saved the day over and over again, and after the show is over will provide some of the most thrilling stories of the entire war Then there is the route (4) to strategic Alaska, and the possibilities of this are yet to be realized When they are, we will chalk up another victory for the vision of American air strategists

The Navy counterpart of all this, with great activity in the Pacific theater especially, is the Naval Air Transport Service, under Comdr Clarence Schildauer When we first entered the war, numbers of Consolidated and Martin patrol bombers of the PBM PBY, and PB2Y types were converted into cargo carriers More recently the trend has been toward land-based transports This is confirmed by the fact that only the prototypes of such flying boats as the Boeing *Sea Ranger* and Martin *Mars* were accepted, also by the recent cancellation of the Nash contracts for Sikorsky VS-44's.

That the combined long range air service of the Army's ATC and Navy's ATS has turned the tide in the Solomons and New Guinea is the specific testimony of Capt Eddie Rickenbacker

Air Troosport is the New World

In the postwar world, the airplane will dominate—as it now dominates during the war itself. A glance at any globe will show how thousands of miles are being saved by the new air routes, and with no important city in the world farther than 60 hr of flying time from any other, geographical barriers will be down This war has proved to the hilt that there is no freedom *anywhere* unless there is freedom *everywhere* The problems of *maintaining* world freedom will be as difficult as the problems of *winning* world freedom and will be with us much longer The airplane will be decisive in both

Materials Laboratory

(*Continued from page* 237)

but with extension of air transport all over the world, they are again of current interest Foreign arrivals are multiplying daily, and the question of quarantine procedure and fumigation increases in importance Water conditioning, both in regard to boiler-heater ease and maintenance, also drinking purposes, was recently brought to the fore by extension of airlines into Mexico, where new areas had to be investigated for water supply Mr Brower has strong faith in making the conclusions on these subjects of common benefit through the newly added aviation committees of the Cooperative Research Council

The laboratory pioneered in attempts to complete and standardize the identification codes of aluminum alloys before this had advanced even to where it is now, and there is still much to be done under this head.

Achievements on standardization of identifying color codes on lines were quite significant in the period from 1937 to 1940. A study of the systems in use by Douglas, American, the U. S. Army, and the ASA division of the ISA revealed considerable confusion Different makes of planes used by the Army but with company codes built in caused much lost time, for unless some one knew with certainty which system had been used, this had to be determined by trial and error. This led to a recommendation by the laboratory to adopt the Army system, since at this point a majority of planes were in Army service Douglas agreed to turn out new models (DC-4's) in accord with this system, but would not change older models in production In 1940, however, the advantages became more evident, and now nearly all are on one system Mr Brower puts forth the hope that after the war all aircraft companies will continue with a uniform system

New hydraulic fluids, and the use of aromatic petroleums bring new problems of investigation of materials, particularly with the xylol and toluol types of aromatic petroleum With the allowance of 10 to 15 percent of these in aviation fuels, their action on rubber and synthetic hose and lines has to be carefully studied.

All these, and many other problems, are the concern of the Materials Laboratory, with a continual stream of samples and new products to be tested Rather than spend time developing their own products, they believe in passing information and recommendations on to the commercial field, where there is nearly always swift cooperation to meet new needs.

Wheel Maintenance

(*Continued from page* 247)

to bear on tire bead, is a short hinged arm which separates tire from flange. A bolt through collar and axle anchors the attachment Damage to tire and flange by hammering is thus eliminated.

Tires which are more than slightly damaged are sent to the factory for repair. Tubes are ducked in a tank, held under water by a clamped frame, and inflated for leak testing. Vulcanizing is done in the shop The site of puncture is burned out by a heated rod of suitable size to obtain a smooth tearproof edge for vulcanizing A soft rubber plug, slightly thicker than the tube, is inserted and held under heat and pressure until smoothly merged with the tube A good job is indistinguishable by touch from the original surface.

As is so often the case, the ingenuity and inventiveness of the maintenance men has reduced expense and increased efficiency all along the line

Ground Time

(*Continued from page* 233)

load of 6,000 lb at 180 mph has a value of 540 ton-miles-per-hour as a commercial carrier Under present tonmile Air Express rates the earning power is $432 per hour At rates comparable to those of TACA in Central America it would be $151. Larger

capacity planes sharpen the focus. A Curtiss C-46 carrying seven tons at 180 mph. has an hourly value of $1,008 at Air Express rates. Does that make ground time costly?

Let's examine the reasons for present ground delays, disregarding the problems of personnel which will become less evident as men are trained to the work.

A survey made recently by the writer, at a station where ground time averaged 1 hr., indicated that only 20 min. was needed for physical movement of cargo into and out of the plane interior. The remaining 40 min. was used by four experienced handlers in unlashing and lashing the cargo to the walls and deck with ropes. At the lowest C-47 earning power noted above, without reckoning handlers' salaries, each cargo through that station would cost $100 just to be made secure—$660 if a C-46 were tied up at 80c ton-mile rates.

Aircraft design engineers with these things in mind will eventually place in service sectionalized or removable fuselage cargo planes, or other improved types that will permit pre-loading. But the three or four cargo types now being produced in quantity for the military will form the equipment backlog for air freight operators for a considerable period after the war, for obvious reasons. And these planes do not lend themselves to radical major changes in design. Multi-engine monsters rushing 20 to 30 tons of cargo through the upper air at 300 mph. or more will certainly be a fact in the not-so distant future, but high ton-mile rates may be necessary to write off initial cost of the first of these before obsolescence sets in.

By the pound, passengers will always pay the highest fare, and it may easily be found that the most economical course will be to depreciate the new planes in passenger service first, to bring investment to a level compatible with competitive freight tariffs.

It has been found that planes whose decks are tilted when on the ground take nearly twice as long to load as those with level decks. Since center of gravity is forward, it is the practice to stow the heaviest shipments toward the front of the cabin, leaving the more readily adjustable weights for the balance of the space. The heavier the shipment the more difficult it is to manhandle up a slope for 15 to 20 ft. To overcome this in present planes either the tail must be raised by some convenient means, or the forward gear dropped into a suitable depression from which it must later be towed out—all 13 tons of it. The former method seems the simpler of the two.

Belt loaders and other mechanical loading devices to handle cargo between ground or loading dolly and the plane deck are not only labor savers, permitting smaller crews, but they are definite time savers in that they set a fast, rhythmic tempo that keeps men moving. Until all cargo planes have decks a uniform distance above ground, permitting standard height docks and dollies, these devices will pay for themselves many times over. (Present heights of various types of cargo plane side door openings range from 4½ to 9½ ft. above ground).

Cargo lashing is important enough to deserve special attention. Heavy cargo must be tightly fastened. In rough air, a 500-lb. box with a half inch of slack in its lashings can soon batter its way through a plywood deck.

Converted airliners have been equipped with flush type floor rings, side rib wall brackets, and horizontal wall bars at varying heights. These gadgets are provided for the use of single rope ties. The Lilliputians swarming over sleeping Gulliver and tying him down in every direction have a modern counterpart in air cargo crews. Typical lashed loads appear to have had a gigantic web woven over them, with knots everywhere—and no two knots alike. Hurried unloading crews are often forced to cut loads loose.

Railroads use nailed metal straps or ratcheted bars with patent pressure-tighteners to secure loads in cars. Driven wedges and blocks prevent vibration. The problems of constant vibration are almost non-existent in large planes as are those of abrupt stops and starts. Most important factors to contend with are lurching side-to-side and up-and-down movements. Another consideration of less frequent moment is the terrific rearward inertia pressure exerted by cargo as the plane gathers speed for takeoff.

The use of single ropes is a shameful waste of time and money and seldom achieves a permanently tight load. Hemp, sisal, manila, and cotton all have stretch factors, and also such rope tends to slip away from binding points. A ¾-in. sisal rope net with 6-in. square mesh, designed by the writer in conjunction with airline officials, has proven to have considerable advantage over single ropes. By distribution of cargo strain, the normal stretch of the rope is reduced to a minimum. Tightness is obtained by catching the free edge of the net to the deck with snap hook fasteners of adjustable length. Built primarily to speed up lashing, results have been gratifying. Nets are most applicable to lashing down medium weight cargo of widely varied shapes, but they are not the ultimate answer.

Webbed strap belting is now being tried out in place of ropes. A distinct improvement on rope as to stretching quality—but even with fast tightening buckles little time can be saved, since a large number of individual tiedowns will still have to be made.

The most practical method proposed so far as not to attempt to tie cargo tight but to provide rigid, removable bars or stanchions between which the box or carton may be held stationary without using force. Such bars could be ratcheted into notched channels to provide proper tension. Exposed inner ribs provide foundations for such channels and other brackets, while holes in the decks or metal base plates can carry the lower ends.

Cargo moving by air today has, due to the mechanical nature of the war, a very high ratio of weight to volume. It is not unusual to reach maximum payload weight limit with a cargo utilizing but 15 to 20 percent of the available cubic space, and averages of 50 percent are about normal. This leaves the entire upper half of the storage space empty, since weight must be spread evenly throughout the deck space to get a balance. With heavier shipments on the bottom, lighter weight cartons and packages are distributed on top. In order to secure a tight load the necessary pressure of lashings often cuts into or crushes the fragile packages on top.

By installing light framework suspended from the upper ribs on each side of the center aisle at a convenient height, with rope or woven wire shelving, lightweight shipments could be carried in this hitherto wasted area. Requiring little if any lashing down, they could be quickly stowed and well protected from damage enroute. In addition, the heavy deck shipments would be better secured, not being covered by many small items. In peace time, when character of air freight can be expected to change to a high volume-low weight ratio, and space becomes a premium factor in plane loading, then further interior sectionalizing will be necessary.

Fore and aft shifting of deck loads can be reduced by the use of removable blocks that can be fastened to the deck at pressure points. Aftward shifting is most common, and as rear bulkheads are not so situated as to form a brace for cargo, handlers find it difficult to prepare in order to withstand this motion. With stanchions in place, such blocks would not be necessary.

These changes will perhaps be engineered into the cargo plane of tomorrow. But the operator who by virtue of a desire to be first in the field finds himself with a fleet of C-46, C-47, or C-54 planes will find difficulty in bringing his costs into line with the public demand for competitive air freight rates—unless he can cut his ground time losses to the barest minimum, for time is the essence of all things.

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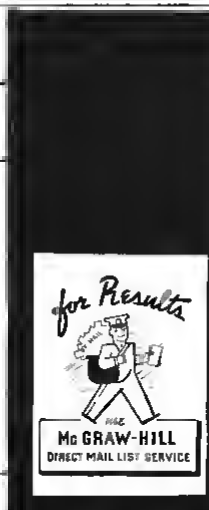

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A TANNEWITZ DI-SAW (Big Bertha Model) chain filing inside of die at the plant of DOUGLAS AIRCRAFT CO., Santa Monica, Cal

In expediting the production of much needed tools and dies, templates and in many special applications, TANNEWITZ DI-SAWS come close to being worth their weight in gold.

It is conservatively estimated that they save an average of 70% of the time and cost involved in making inside and outside cuts and are particularly advantageous for inside and outside filing and polishing. In many instances they are turning out work in as little as ONE-TENTH of the time formerly required.

With models ranging in capacity from 24-inches between blades to 48 inches, or even larger if desired, the great time and money saving potentials of TANNEWITZ DI-SAWS are available for work of practically any size. Get the complete facts—write for "DI-SAW BULLETIN."

STANDARD MODEL M-24

Finest standard DI-SAW on the market. Carries full 24" wheels which makes for faster, straighter sawing

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